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A Novel Plan for Stopping a Landslide at Mount Vernon

By N. H. Darton*

Most Americans who visit the nation's capital make a pilgrimage to Mount Vernon, the beautiful old home of George Washington, and everyone returns charmed with the picturesque beauty of the place. Very few persons are aware that not long ago this shrine of the nation was in danger of serious injury from landslides.

The mansion at Mount Vernon is located on a high bluff commanding an extensive view of the Potomac River in front. As shown in the accompanying view, a broad lawn slopes from the house down to the edge of the bluff. At this point begins a steep declivity with more than 100 ft. drop to the edge of the Potomac. The river here is a wide, shallow, tidal estuary, but the steady action of waves and tidal currents causes constant erosion of the high bluff on which the mansion at Mount Vernon stands. This bluff is made up of layers of clay, sand and soft sandstone, and the undercutting by the river, with the resulting landslides, has doubtless been in progress for ages. More than a century ago, in Washington's time, extensive landslides occurred on the front of the bluff. Examination of the deer park, which occupies the steep slope from the edge of the lawn to the river, shows long blocks of fissured ground which many years ago broke away from the crest of the bluff and slipped toward its foot.

Mount Vernon on the Potomac River, the Home of Washington

A few years ago, evidences were discovered that another landslide was beginning and the movement of the ground was extending so far back as to threaten the broad lawn in front of the mansion itself. It was evident that if the movement proceeded, the beautiful growth of trees which clothe the slope from the lawn to the river would be endangered. There was, of course, the added likelihood that further movement might take place until eventually the foundations of the mansion itself might be endangered.

The superintendent of the estate, Harrison Dodge, consulted with engineers as to what could be done to stop the ground movement. The use of piling and other methods of holding the ground was considered, but it was recognized that unless very heavy construction was employed the movement would continue. Finally the writer was consulted and he undertook a study of the strata of which the bluff was composed and the underground water conditions. It was the writer's opinion that the moisture in the beds of clay and sandstone had much to do with their plasticity and movement. One bed of sandstone in particular contained so much water that it kept the adjoining strata continuously wet. The writer, therefore, advised that if the water in this sandstone could be drained away, the bluff would probably remain stable.

In accordance with this advice, a small drainage tunnel was started in the bottom of the sandstone stratum and was driven back from the river front a distance of some 200 ft. From this drainage tunnel a considerable flow of water at once started and continued for several months. At the end of that time the flow gradually diminished

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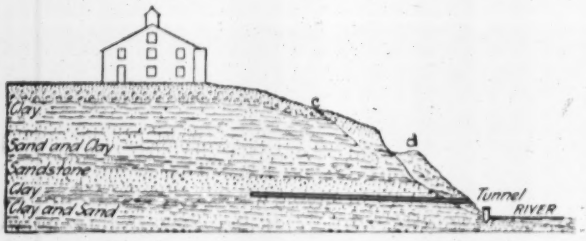
and now remains of moderate amount but practically constant. The draining of the overlying strata has apparently been so thorough that they are now able to sustain the



SECTION THROUGH MOUNT VERNON BLUFF

(Showing permeable strata and drainage tunnel in sandstone; d, old landslide in deer park; c, new landslide threatening lawn)

load upon them without further movement. A masonry wall along the river at the water's edge prevents further undercutting by the waves.

Equivalent Uniform Loads for Long-Span Bridges

BY D. B. STEINMAN*

The usual methods of calculating the live-load stresses in trusses involve either an undue expenditure of time, if moving concentrations are used, or a sacrifice of accuracy if equivalent uniform loads are employed. The following method obviates both of these disadvantages by giving the exact equivalent uniform loads corresponding to the different panel-points of a given span. Cooper's E60 loading is assumed, but the values can easily be modified for other loadings.

The equivalent uniform load p for producing the maximum bending moment or chord stress at the center of any given span L is given by the formula

$$p = 6000 + \frac{46{,}080{,}000}{L^2} \qquad (1)$$

provided the span exceeds 280 ft. Thus, for spans of 400, 500, 600, 700 ft., the equivalent loads are 6289, 6185, 6128, 6094 lb. per lin.ft. The last term of the above formula, representing the excess over the uniform train load of 6000 lb., will be denoted by e.

For the maximum bending moment at any other point of the span, distant L_1 from the nearer end, the equivalent uniform load is given by

$$p = 6000 + k \qquad (2)$$

where k is the inverse ratio of L_1 to the half-span. Thus, for

L_1 =	$0.2\,L$	$0.3\,L$	$0.4\,L$	$0.5\,L$
k =	$\frac{5}{2}$	$\frac{5}{3}$	$\frac{5}{4}$	1

EXAMPLE—For a span of 775 ft. (Ohio River),

$$e = \frac{46{,}080{,}000}{L^2} = 77 \text{ lb.}$$

There are 20 panels in this span; hence,

for panel-points 4 and 16, $p = 6000 + \frac{1}{4}^0\ (77) = 6192$

for panel-points 6 and 14, $p = 6000 + \frac{1}{6}^0\ (77) = 6128$

for panel-points 8 and 12, $p = 6000 + \frac{1}{8}^0\ (77) = 6096$

for panel-points 10, $p = 6000 + \frac{1}{10}^0\ (77) = 6077$

These values checked exactly those obtained by actual application of wheel concentrations, giving the critical stresses with an expenditure of only about one-fourth as much time and effort. The stresses, of course, obtained by multiplying the equivalent uniform load by the areas of the influence diagram or by the ordinate coefficients.

The above formulas are exact, being capable of simple mathematical demonstration. The only limitation is that L_1 must exceed 140 ft. In the derivation of the formulas it is assumed that the structure is a simple span; but the results hold good for continuous trusses and other indeterminate structures, as the curvature of the influence line does not sensibly affect the value of the equivalent uniform load.

The writer is indebted to Gustav Lindenthal, Consulting Engineer, for permission to publish the above.

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Progress on Arrowrock Dam

BY CHARLES H. PAUL*

During the working season of 1914, the concrete placed in the Arrowrock Dam and spillway amounted to 359,240 cu.yd.† In four consecutive months, more than 200,000 cu.yd. were placed, making an average of over 50,000 cu.yd. per month for that period. The best monthly record was made in June, when 56,520 cu.yd. were placed in 26 working days of 16 hr. each, an average of 2174 cu.yd. per day. Three 1-cu.yd. mixers were in use, and as no other mixers were available it is evident that there was very little trouble with the concrete plant and that it and its operators were kept up constantly to a high degree of efficiency. The average actual output of each 1-yd. mixer per day, during the best month, was 711 cu.yd., the rest of the yardage being accounted for by a small amount of plum rock that was placed during that month.

The concrete aggregate was hauled in over the Arrowrock R.R. in standard-gage bottom-dump cars from a gravel pit and screening plant 13 mi. below the dam. This material was dumped into storage bins directly over the mixers. Sand-cement, consisting of 55% portland cement and 45% pulverized granite, reground to pass 90% through the 200 sieve, was manufactured at Arrowrock, and after being tested for fineness, soundness, tensile strength, etc., was conveyed in bulk from the storage bins to bins over the mixers, through 3-in. pipes, by means of compressed air. Measuring boxes, controlled by air-operated gates, portioned out the sand, gravel and cobbles from their respective bins to the mixers. The sand-cement was weighed into the batch, on account of the difficulty of measuring accurately by volume material of such fineness.

The regular mix of concrete was about 1 part sand-cement, 2½ parts sand, 5½ parts gravel and 2¾ parts cobbles, although this mix was changed slightly from time to time. A richer mix was used for a thickness of about 10 ft. at each face of the dam. The mixing plant consisted of three 1-cu.yd. mixers.

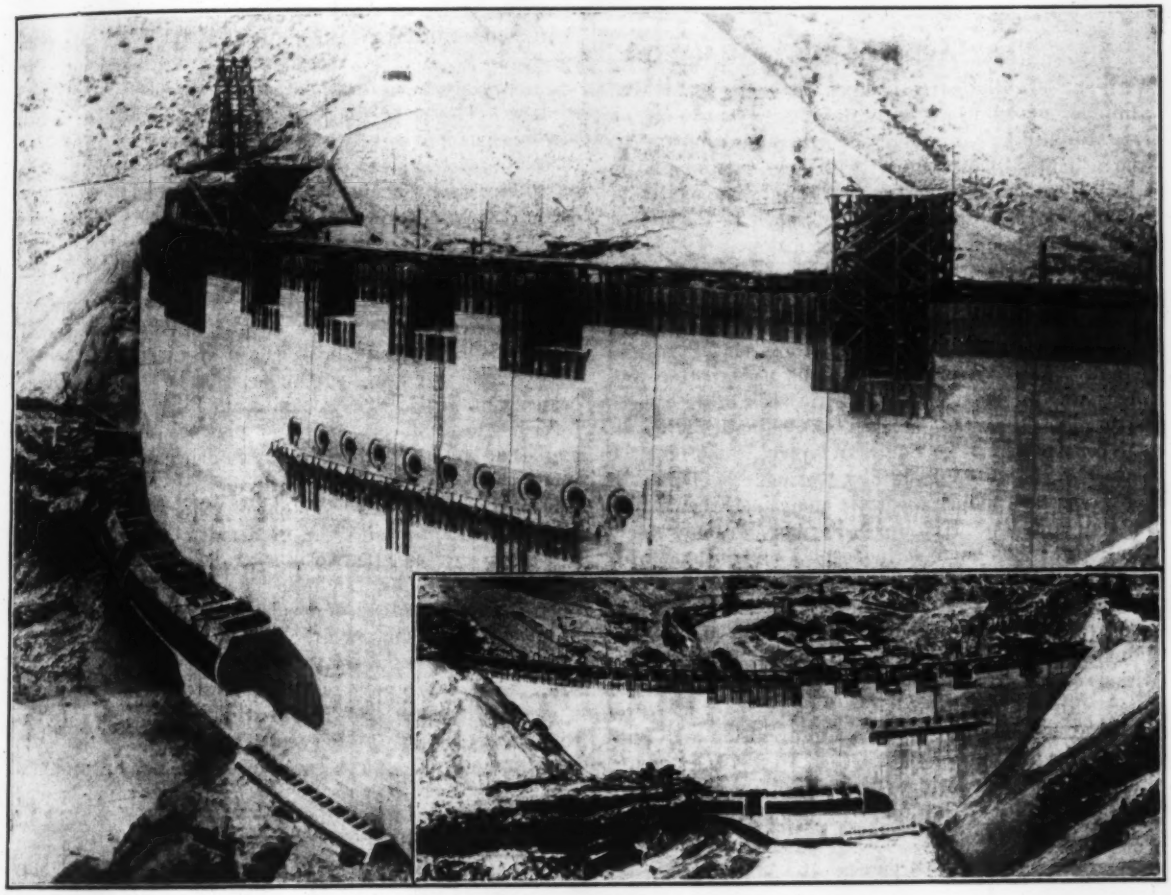
*Construction Engineer, Arrowrock Dam, Arrowrock, Idaho.

†Previous articles descriptive of the Arrowrock Dam have appeared in this journal under dates of June 6, 1912; Jan. 16, Mar. 20, July 17, 1913, and July 11, 1914. The Arrowrock Dam, which when completed will be the highest in the world, is near Boise, Ida., and can be reached by the traveler en route from Omaha or Ogden to Portland, Ore., by leaving the main line of the Oregon Short Line (Union Pacific System) at Nampa for Boise, 20 mi. distant, and by proceeding from Boise a few miles by a special railway line to Arrowrock.

Three 2-yd. rocker-dump electric trolley cars transported the concrete from the mixers to a distributing tower, where it was dumped into cableway buckets, which, after being hoisted and conveyed to the point desired, dumped automatically into a movable hopper suspended from a carriage on the same cableway. A chute was attached to this hopper, the free end of which could be moved to any point desired. The concrete was mixed with only enough water to make it plastic and was not "sloppy." By keeping the chute at an angle of about 25° with the horizontal, it was found that the plastic consistency was sufficient to make the concrete run freely, and that an excess of water was not necessary or desirable.

coming season. The lowest point of the foundation, which is hard granite, is more than 100 ft. below the water surface. The completed dam will have a total height of 350 ft.

The river has been turned out of the diversion tunnel, which has been filled with concrete, and is now passing through the sluice gates, the trash-rack structure for which is just at the present river level (see views). The structure just above and at the left is the trash-rack structure for the lower set of regulating outlets, ten in number, each controlled by a 58-in. balanced valve. The upper set of ten regulating outlets (valves not yet installed) may be seen plainly in the accompanying views.



PROGRESS VIEWS OF ARROWROCK DAM, IDAHO, JANUARY, 1915

(Upper view, looking south along the upstream face; lower view, looking downstream)

The accompanying photographs show the dam as it looked in January, 1915. The system of distributing concrete just described was changed just below this elevation (as was originally planned) because of the difficulty in still covering the work with cableways, on account of the long curve and narrower section. The main cableways now dump the mixed concrete into two stationary loading hoppers, one of which may be seen at the right. The electric dump cars take the concrete from these towers along the track to any point desired. This track, and the hoppers, are raised as the work progresses, and this move is made with very little delay.

The dam is now (Jan. 29, 1915) finished to a height of more than 200 ft. above water surface. It will be raised about 50 ft. higher, to completion, during the

The excavation for the spillway is practically completed, and about 40% of the reinforced-concrete lining of the spillway trench is in place. The spillway lip will be 400 ft. long, extending back from the right abutment of the dam beyond the limits of this photograph. The crest of the spillway lip will be 10 ft. below the top of the dam.

Concrete work has been discontinued for the winter. The dam will be finished during the coming season, about a year and a half ahead of schedule time.

The Arrowrock Dam is being built by the U. S. Reclamation Service for the storage of water for the Boise Project. It is in the Idaho District, of which F. E. Weymouth is Supervising Engineer. James Munn is Superintendent of Construction.

Wind Stresses in Highway Bridges

By R. Fleming*

SYNOPSIS—Treating highway bridges in the same manner as railway bridges were treated in a previous article, Feb. 11, 1914. Problem complicated by lateral forces due to traffic. Present day specifications, and variation of practice.

This article purposes a review of the varying assumptions that have been made regarding the wind stresses in highway bridges.

Early American Writers

Whipple—In the early part of 1847 there appeared a pamphlet of 48 pages with the title, "An Essay on Bridge Building, containing analyses and comparisons of the principal plans in use, with investigations as to the best plans and proportions, and relative merits of wood and iron, for bridges. By S. Whipple, C. E., Mathematical and philosophical instrument maker. Utica, N. Y. H. H. Curtiss, printer, Devereux Block, 1847." After distributing 50 or 60 copies among friends, the author bound the remainder of the edition with "Essay No. II on Bridge-Building Giving Practical Details and Plans for Iron and Wooden Bridges," which he had written and printed later in the year. This little book of 120 pages and 10 plates was the pioneer in the mathematics of bridge construction. To Squire Whipple, its author, the inventor of the Whipple bridge, belongs the honor of being the first to publish a correct analysis of the stresses in a simple truss. His work did not become widely known. In 1869 he took the copies remaining of his original edition and bound them "with an appendix, containing Corrections, Additions & Explanations, Suggested by Subsequent Experience: to which is annexed an Original Article on the doctrine of Central Forces." This addition of about 150 pages the author prepared and printed with his own hands.

In 1872 an enlarged and rewritten edition was published by the D. Van Nostrand Co. In 1873 a chapter of 35 pages on Drawbridges was added. From a copy of this 1873 edition, the following quotations regarding swaybracing are taken.

> The primary and essential purpose of a bridge is to withstand vertical forces which are certain and, to a large extent, determinate in amount . . . . . But the lateral or transverse forces to which a bridge superstructure is liable, are of a casual nature, depending upon conditions of which we have only a vague and general knowledge; . . . . But in arranging his system for securing lateral stability and steadiness, science can lend him but little assistance. . . . . He knows the wind will blow against the side of his structure, but whether with a maximum force of one hundred pounds, or as many thousands, he has no means of knowing with any considerable degree of certainty or probability . . . No attempt will be made here to assign specific stresses as liable to occur in sway rods or braces, based upon calculations from the uncertain and indeterminate elements upon which the lateral action upon bridges depends. But judging from experience and observation, it may be recommended that iron sway rods be made of iron not less than ⅝ inch in diameter, for bridges of five panels or under, ¾-in. from six to ten panels inclusive. For twelve and fourteen panels, ¾-in. for ten middle panels and ⅞-in. for the rest; and for sixteen the same as last above, with the addition of a pair of 1-in. rods in the end panels.

*American Bridge Co., 30 Church St., New York City.

These are opinions from the father of modern bridge building, written only 42 years ago.

Boller—Boller's "Iron Highway Bridges," first published in 1876, which has passed through several editions, says,

> The horizontal or sway bracing may consist of very light rods, if the floor is well laid, forming as it does a very effective system of bracing against lateral movement. Rods from ¾- to 1-in. round will cover all but extreme requirements, and they are attached by any convenient means to the floor-beams near their point of support.

In modern textbooks calculation has taken the place of speculation. Most of what has been written about the wind stresses in railroad bridges* applies to highway bridges. The same questions of the intensity of wind pressure per unit of area exposed, and the amount of area to be considered as exposed surface, are to be met. Induced stresses, load uniform or moving, and lateral forces other than wind are also to be considered.

Changed Traffic Requirements

The whole subject of loadings on highway bridges is being revised. This is the day of heavy concentrated loads. Many present bridges are seriously overloaded by the traffic coming upon them, especially in the floor-beams and joists. They were often built to carry uniform live-loads of, say 125 lb. per sq.ft. for the floor-beams and 80 or 100 lb. for the trusses. Sometimes a road roller was mentioned in the specifications. Manufacturers are constantly increasing the weight of road rollers and traction engines, and with the good-roads movement many bridges are called upon to carry rollers and engines for which they were not designed. Then there is the automobile, which, regardless of local regulations, is often run at a speed of 30 mi. per hr.

But the severest tests to which some of our highway bridges are being put are those from the auto trucks.** The traffic of towns and cities now reaches far out into the country. The road roller runs slowly, while the auto truck may be driven at a speed of 12 mi. per hr. and two trucks may meet or pass each other on the same bridge. A load of 10 tons is often carried and the weight of the truck adds another 6 tons. (In New York City a load of 75 tons has been carried on a truck weighing 10 tons, most of the load being on the two rear wheels.)† Trucks are being made heavier and with increased capacity. Greater impact stresses are induced and the tendency to both vertical and lateral vibration becomes greater. Sometimes centrifugal forces are introduced. All this is particularly true of the auto truck when fully loaded and with a driver ignorant or indifferent to loadings, speed, and the strength of bridges. One writer,‡ however, does not think the vibration effects greater than those produced by a horse and wagon. Anyone who has stood on a country bridge of 150-ft. span while a horse drawing a light buggy was crossing at a trot may have felt a decided jolt-

*Fleming, Wind Stresses in Railroad Bridges, "Eng. News," Feb. 11, 1914.

**Motor Truck Loading on Highway Bridges, "Eng. News," Sept. 3, 1914.

†Seaman, Proceedings, Am. Soc. C. E., December, 1911.

‡Neff (Am. Assoc. for Advancement of Science), "Engineering and Contracting," Jan. 22, 1913.

ing of the whole structure, a condition largely remedied by rigid connections and stiff members.

Legislation at no distant date may be invoked requiring bridges to be placarded with the loads they can safely carry and forbidding under penalty excessive loads being brought upon them.

Electric-car lines are being extended, and cars are being increased in weight and run at greater speed. When a highway bridge carries electric cars it becomes in reality a miniature railroad bridge. City or county officials who, without examination by a competent engineer, will sanction the use of existing highway bridges to carry electric cars, belong to the class of undesirable citizens.

Lateral Forces Other Than Wind Pressure

The assumed wind load in bridge specifications includes all the lateral forces whether so stated or not. The writer believes that this is sufficient (in nearly all present specifications) to take care of the increased lateral forces due to changed traffic requirements. With the exception of the electric car, it is improbable that the full wind load will be acting at the same time that the lateral vibration occurs, due to the moving load. It should be remembered that, if by any means a highway bridge is blown over, there is not likely to be any loss of life, neither will traffic be seriously interrupted. The actual loss to the authorities is little more than the cost of the structure itself. Hence, excessive bracing in all bridges to guard against a remote possibility in a single one is unnecessarily expensive. With a railroad bridge it is different; provision must there be made for remote possibilities.

The weakness of lateral systems of highway bridges in the past has not been so much in the assuming of loads as in the abominable details used. Witness the common practice of 25 years ago and still prevalent in some quarters of fastening the lower laterals in a nondescript way to the floor-beams, which, in turn, are suspended from the pins by U-bolt hangers; or, the top laterals having bent eyes taking the top-chord pins and pulling against struts attached to the same pins by bent plates. It is better to design for a safe and sane wind loading, taking care of induced stresses, and with all details fully up, than to proportion the body of the lateral members for larger stresses and use inefficient details.

In high-truss bridges the compression chord is kept in alignment by the top lateral system. In the pony truss, recourse is often had to doubtful expedients. "One has only to shake the top chord of a pony truss to see how loosely it is secured laterally and to demonstrate its lack of fixity at intermediate points."* With the moving loads now coming into use, the pony truss is doomed. In some specifications it is prohibited altogether.

The wind is generally assumed to blow horizontally, but it may vary greatly from the horizontal. For high bridges in exposed localities, the upward pressure should be taken into account; the end anchorage should provide for any possible uplift and against the structure being moved off its seats either by wind pressure or by a blow from a passing object. A study of the wreck of the High Bridge over the Mississippi River at St. Paul† is interesting.

*Smith, Proceedings, Indiana Eng. Soc., 1911, p. 209; "Engineering Record," Jan. 21, 1911.

†Turner, Trans. Am. Soc. C. E., June, 1905, Vol. LIV, p. 31.

Present Specifications

Schneider—Passing to well known specifications, the American Bridge Co. or Schneider specifications for steel highway bridges read:

> The wind pressure shall be assumed acting in either direction horizontally:
>
> First. At 30 lb. per sq.ft. on the exposed surface of all trusses and the floor as seen in elevation, in addition to a horizontal live-load of 150 lb. per lin.ft. of the span moving across the bridge, but not less than 300 lb. per lin.ft. shall be used for bracing of loaded chord nor less than 150 lb. per lin.ft. of unloaded chord.
>
> Second. At 50 lb. per sq.ft. on the exposed surface of all trusses and the floor system.
>
> The greatest result shall be assumed in proportioning the parts.

Cooper—Probably more highway bridges have been built in accordance with the specifications of Theodore Cooper than any other. The paragraphs stating amount of lateral forces are:

> To provide for wind and vibrations, the top lateral bracing in deck bridges and the bottom lateral bracing in through bridges shall be proportioned to resist a lateral force of 300 lb. for each foot of the span; 150 lb. of this to be treated as a moving load.
>
> The bottom lateral bracing in deck bridges and the top lateral bracing in through bridges shall be proportioned to resist a lateral force of 150 lb. for each foot of the span.
>
> For spans exceeding 300 ft., add in each of the above cases 10 lb. additional for each additional 30 ft.

Johnson, Bryan & Turneaure; Merriman & Jacoby; Ketchum; and others in their textbooks follow Cooper's specifications regarding wind pressure. Others, as Marburg, and Burr & Falk, quote both the Schneider and the Cooper specifications.

Waddell—Waddell in his "Ordinary Highway Bridges" assumes a wind pressure of 40 lb. per sq.ft. for spans 100 ft. and under, 35 lb. for spans 100 to 150 ft., and 30 lb. for spans greater than 150 ft.; these pressures to be increased 10 lb. for bridges in unusually exposed locations. The loads are considered moving.

> The total area opposed to the wind is to be determined by adding together the area of the vertical projection of the floor and joists, and twice the area of the vertical projection of the windward truss, hub plank, guard rail, and ends of floor-beams.

In his "Specifications for Steel Highway Bridges," 1906, the wind loads per lineal foot of span for both the loaded and unloaded chords are taken from curves shown on a diagram. The diagram was figured (for a clear roadway of 20 ft.) with intensities varying from 40 lb. for very short spans to 25 lb. for very long ones. For spans up to 600 ft., the curves show loads from 200 to 355 lb. per lin.ft. of bridge on the loaded chord and 100 to 265 lb. on the unloaded chord, according to the length of span and the class of the bridge. For wider structures, the wind loads are to be increased 2% for each foot of width in excess of 20 ft.

Greiner—The "Specifications for Steel Stationary Bridges," by Greiner, require that

> for city, interurban and country bridges the lateral force against unloaded chords shall be assumed not less than 150 lb. per lin.ft. plus 10% of the uniform load on one car track or on a width of 12 ft., and for the unloaded chords 150 lb. per lin.ft. In cases where a lateral force of 30 lb. per sq.ft. on 1½ times the vertical projection of the structure produces greater stresses than the above loads, it shall be considered. All lateral loads shall be treated as moving.

Ostrup—Ostrup, in his "Standard Specifications for Highway Bridges," calls for wind bracing to be designed to resist one of the following lateral loadings, whichever produces the greater stress: (a) *Structure unloaded,* 50 lb. per sq.ft. on the exposed surface of all trusses and the floor as seen in elevation; or (b) *Structure loaded,* bridges (of all classes) carrying highway traffic only, 30 lb. per sq.ft. on the exposed surface of all trusses and the floor as seen in elevation in addition to a uniform

load of 150 lb. per lin.ft. of structure applied on the loaded chord; or (c) *Structure loaded,* bridges of all classes carrying electric-railway traffic, the same loading as under (b) except that the additional uniform load is 300 lb. per lin.ft. of structure and is applied 7 ft. above the base of rail. The minimum value of the pressure is to be 250 lb. per lin.ft. for the loaded and 150 lb. for the unloaded chord of the structure.

BOWSER—Bowser, in a "Treatise on Roofs and Bridges," gives 30 lb. per sq.ft. of exposed surface of both trusses as the maximum wind load upon a highway bridge. To estimate the 30-lb. pressure when the surface is not known, he writes, "it is customary to use the following rule: Take 150 lb. per lin.ft. per truss, or 75 lb. per lin. ft. for each chord."

MERRIMAN—In the earlier editions of Merriman's work, "A Textbook on Roofs and Bridges," are found the sentences:

> For a highway bridge the surface exposed to wind action is usually taken as double the side elevation of one truss. If the area of this be not known, an approximation to its value may be found by taking it as many square feet as there are linear feet in the skeleton outline of the truss.

A number of the states, through highway commissioners or otherwise, have issued specifications for steel highway bridges. Some of them are incomplete and written by men without a clear knowledge of the subject. Below are given quotations from these and some other sources, as to horizontal wind pressure.

COLORADO—300 lb. per lin.ft. on the loaded chord and 150 lb. per lin.ft. on the unloaded chord.

ILLINOIS—Cooper's Specifications for Highway Bridges, ed. of 1909, "except as hereinafter specified or as may be specially indicated on the drawings."

MICHIGAN—No mention made of wind loads but they may be covered by the paragraph, "Any questions that may arise as to the quality of material and labor shall be settled in accordance with the provisions of Theodore Cooper's Specifications for Steel Highway Bridges, under Class B-1.

NEBRASKA—300 lb. per lin.ft. on the loaded chord and 150 lb. on the unloaded chord.

OHIO—Same as the Cooper Specifications, ed. of 1909.

VIRGINIA—300 lb. per lin.ft. on the loaded chord, 150 lb. of which is to be treated as a moving load, and 150 lb. per lin.ft. on the unloaded chord.

MASSACHUSETTS—The Massachusetts Railroad Commission, George F. Swain, Consulting Engineer, specifies that, for bridges carrying electric railways "a lateral force of 50 lb. per sq.ft. on the unloaded structure, or of 30 lb. per sq.ft. on the loaded structure, shall be provided for. The surface of the unloaded structure shall, in the case of a truss, be taken as twice the area of the vertical elevation of one truss, plus that of the floor; and in the case of a girder, as 1½ times the vertical surface. The surface of the loaded structure shall be that of the unloaded structure plus a vertical surface 10 ft. in height and 50 ft. long, the pressure on which is to be considered a moving load upon a car."

NEW YORK—The Department of the State Engineer and Surveyor of New York specifies: "The intensity of the wind pressure shall be assumed at: First, 30 lb. per sq.ft. on the exposed surface of all railings, trusses, trestle posts, bracing and the floor in addition to a load of 150 lb. per lin.ft. applied at 4 ft. above the floor line for all bridges which do not carry electric cars, and 300 lb. per lin.ft. applied 8 ft. above the floor line for all bridges which do carry electric cars. Second, 50 lb. per sq.ft. on all exposed surface of the unloaded structure. All parts shall be proportioned for that one of these loads which gives the greater results, but in no case shall the wind pressure be assumed at less than 100 lb. per lin.ft. at the unloaded chord, or less than 250 lb. per lin.ft. at the loaded chord. All wind loads shall be considered as moving loads."

PHILADELPHIA—The Department of Public Works of the City of Philadelphia specifies for its bridges a wind pressure of 30 lb. per sq.ft. against the side area of all trusses, railings, and the end area of the floor construction. In no case is less than 150 lb. per lin.ft. to be used. In addition the system attached to the floor is to carry a moving load of 150 lb. per lin.ft. of bridge.

HARRIMAN LINES—A number of railway companies have specifications for highway bridges attached to or a part of their specifications for railroad bridges. The Harriman Lines issue separate specifications for highway bridges in which the wind pressure is taken: (a) On the loaded structure at 30 lb. per sq.ft. on the exposed surface of all trusses and the floor system as seen in elevation, together with a moving load of 150 lb. per lin.ft. of bridge. (b) On the unloaded structure at 50 lb. per sq.ft. on the exposed surface taken as [illegible].

U. S. ROADS—The Office of Public Roads, U. S. Department of Agriculture, issues "Typical Specifications for the Fabrication and Erection of Steel Highway Bridges." The Director of the Office states that they are prepared "with the view of furnishing a suitable guide for local highway officials in fixing requirements to which bridge structures must conform." He further writes, "In the past many steel bridges have been very poorly constructed, and it is believed that lack of information on the part of highway officials concerning proper specifications for this class of work has been in a large measure responsible for the unsatisfactory results." It may be remarked that unless the highway officials are reinforced by competent engineers, the use of these specifications will not prevent "unsatisfactory results." The wind loads assumed are a load of 300 lb. per lin.ft. on the loaded chord, one-half of this to be treated as moving, and 150 lb. per lin.ft. on the unloaded chord.

ONTARIO—The "General Specifications for Steel Highway Bridges," of the Canadian province of Ontario are quite detailed in their provisions for wind and lateral stresses. For Class A (bridges suitable for main county roads) in spans of 200 ft. or less, a uniform load of 150 lb. per lin.ft. per span is used on the unloaded chord, and the same with the addition of 150 lb. per lin.ft. moving load on the loaded chord; for spans exceeding 200 ft. the uniform load in each system is to be increased 10 lb. for each 30 ft. of span. For Class B (bridges carrying light rural traffic), same as Class A. For Class C (bridges for heavy traffic in towns and cities), for spans of 200 ft. and less, a uniform load of 200 lb. per lin.ft. of span on the unloaded chord and a uniform load of 250 lb. per ft. in addition to a moving load of 250 lb. per ft. on the unloaded chord; for spans over 200 ft. the uniform load in each system is to be increased 10 lb. for every 30 ft. increase of span.

TYRRELL—Merriman & Jacoby in their enumeration of noncontinuous bridges of 400-ft. span and over include 21 which are exclusively highway. Of these 21 the longest span is that over the Miami River at Elizabethtown, Ohio (destroyed by flood in March, 1913). This structure was proportioned "for a wind load of 30 lb. per sq.ft. acting on the exposed surface of both trusses, and all bracing that is likewise exposed to wind pressure."*

UNIT-STRESSES

In the specifications mentioned, the values allowed for stresses due to combined dead- and live-load and wind are 20 to 30% greater than that allowed for combined live- and dead-loads. The proviso is attached that the section used must not be less than that required for the combined dead- and live-loads. One exception is that of the U. S. Department of Agriculture: these specifications require that the wind stresses be proportioned with the same values as other stresses without allowance for any combination with other loads. This may not be intended, but there is no doubt of the literal interpretation. Another exception is the Waddell specifications, where in highway bridges no reduction of working stress is allowed for any combination of loads. Unless the structure carries an electric railway, it is assumed that the live-load and wind-load cannot act together, "for the reason that no person would venture on the bridge when even one-half of the assumed wind-pressure is acting."

CONCLUSION

It will be seen from the above that the current requirements regarding lateral bracing vary greatly. A number of states have already legislated upon the subject of highway bridges and others will soon follow. As far as lateral bracing is concerned it might be well to divide highway bridges into three classes, those which carry elec-

*Tyrrell, The Elizabethtown Bridge.

tric cars, those which carry heavy loads other than cars, and ordinary country bridges. A different lateral loading should be assigned to spans over 150 ft. than to those under. It is better to state the wind pressure in pounds per lineal foot of bridge rather than in pounds per square foot of exposed surface, because contracts for highway bridges are almost invariably let by competition, and if wind loadings are given in pounds per lineal foot, the designs of different bidders are on the same basis, which may not be the case when given in pounds per square foot.

After a study of many specifications, the writer suggests the following:

RECOMMENDED SPECIFICATIONS

For bridges carrying electric-railway traffic the lateral system shall be designed to resist a lateral force of 300 lb. per lin.ft. on the loaded chord and 150 lb. per lin.ft. on the unloaded chord, for spans of 150 ft. and under. An additional allowance of 10 lb. for every 30 ft. of span shall be made to the loaded chord and 5 lb. to the unloaded chord for spans of more than 150 ft.

For bridges not carrying electric cars, but subject to heavy loads such as auto-trucks, road rollers, and traction engines, the lateral force shall be assumed at 250 lb. per lin. ft. on the loaded chord and 150 lb. per lin.ft. on the unloaded chord, for spans of 150 ft. and under. An additional allowance of 5 lb. for every 30 ft. of span shall be made to each chord for spans of more than 150 ft.

Ordinary country bridges shall be designed for a lateral force of 225 lb. per lin.ft. on the loaded chord and 150 lb. on the unloaded chord with an additional force on the loaded chord of 5 lb. for every 30 ft. of span exceeding 150 ft.

All lateral loads are to be considered as moving loads.

In members subject to stresses from lateral forces alone the unit-stresses may be increased 25% over those assumed for live- and dead-loads. In bridges carying electric cars the unit-stresses in chords and floor-beams for the stresses due to lateral forces combined with those from the vertical forces may be increased 25% over those assumed for dead- and live-loads, but the section shall not be less than that required for the live- and dead-loads. If the track is on curve the centrifugal force shall be added to the lateral live-load. For bridges not carrying electric traffic, unit-stresses of 50% increase may be used instead of 25%.

Provision shall be made for reversal of stress in any member due to any combination of wind with other loads. The end seats shall in all cases be firmly anchored against lateral movement and uplift. In bridges in unusually exposed situations or at a great height above the water the amount of anchorage shall be determined by calculation.

All details shall be designed to carry the stresses in the main members.

Convict Labor on Public Roads in Colorado*

By T. J. Ehrhart†

In 1899 Colorado started to use convicts upon road construction. The development of the system of working convicts without gun guards and solely upon honor was started by Mr. Cleghorn (then Warden). The present Warden, T. J. Tynan, took charge in 1909, and has extended and developed the system.

We find that a certain proportion of the men confined can be advantageously used without guards on the state roads, working the same as any other road camp, under the direction of a superintendent and foreman. At the present time there are about 300 convicts thus employed, or about 30% of the entire number in the penitentiary.

The Warden has full control in the selection of these men, taking their word of honor that they will not attempt to escape or go away. The fact that less than 1% of the prisoners employed on the roads during the last six years have attempted to escape testifies to the manner in which the prisoners keep their word. There are no armed guards of any kind employed at any of the road camps. The number of prisoners to a camp runs from 25 to 50. There is one superintendent at each camp, in charge of the construction and of the men. He is assisted by one to three foremen according to the character of the work and the number of men in the gang.

The men are absolutely free, except during working hours, but they are required to keep within the vicinity of the camp. The night watchman is one of the prisoners, as a rule. The men are sheltered in tents, which are provided with stoves and plenty of warm bed clothing; they are also furnished good, substantial clothing from the penitentiary, tobacco and plenty of good food. They have their ball games and other sports on holidays, and on Sundays have religious services.

The state pays no wages on per diem basis to these men, but allows them (under the law and the regulations of the penitentiary officials) an allowance for their work. This, with other allowance for good behavior, practically cuts their minimum sentence in half. The open-air work is beneficial to their health; they have learned to handle tools and to do a fair day's work, and the fact that they have been trusted certainly has had a beneficial effect upon them.

As far as the effect upon the prisoners is concerned, their employment upon the roads is a success, and even were there no profit to the state the system should be continued for that reason alone. But the state does get returns by the work accomplished. The records of cost show that the total cost in the camps for food, all extras, such as tobacco and other incidentals, and including the cost of food for the stock employed in bringing supplies and in other work, will run from about 60c. to 90c. per day per man. The average cost per man per day actually worked on the road varies from about 80c. to $1.50 per day. The cost of the work accomplished varies with the character of the work, and will run from $500 to $5000 per mile. The economy of the use of prisoners is reached when the road camps contain not less than about 25 to 30 men as a minimum. A camp of 40 to 50 men would be better, as the overhead charges are nearly the same in either case, and if the camp is too small these charges run too high.

The location of the camp and the cost of transportation of the prisoners going and coming are items which need consideration. If a number of short-term men are placed at any great distance from the penitentiary, the cost of bringing them to the work and returning them for a few months' employment would increase the charges considerably.

*Abstract of a paper read at the American Good Roads Congress, at Chicago, Dec. 15-18, 1914.

†State Highway Commissioner, Denver, Colo.

Cost of Railroad Construction in 1830—Those who think the original cost of some of our oldest railways is an important factor in the appraisal of their present value will be interested in the contract prices for the construction of the Hudson & Mohawk R.R., which became a link in the New York Central & Hudson River R.R. This was one of the earliest American railways, construction being begun in the summer of 1830. The contract prices given by the railway's secretary in the "American Journal of Science" in 1832, were as follows: Excavation of sand, 7c. per cu.yd.; excavation of clay, 9c. per cu.yd.; embankment of sand, 8c. per cu.yd.; embankment of clay, 11c. per cu.yd.; broken stone, $2 per cu.yd.; stone blocks, containing 2 cu.ft., 45c. each; castings for chains and runs, 4c. per lb.; spikes, 9c. per lb., 5% discount for cash; grading, $7500 per mile of single track; grading $10,000 per mile of double track.

The track was constructed of white-pine sills with ⅞-in. wrought-iron bands (runs) to carry the wheels. The sills were carried on the stone blocks (45c. each) and under each block was 4 ft. of broken stone ballast, in pits. Each stone chair had four drill holes into which were driven wood plugs, and the rails were held down by spikes driven into these plugs.

The Manufacture of Granite Paving Blocks

SYNOPSIS—A historical summary of progress in stone paving-block manufacture, a description of granite-quarrying methods, a detail description of the process of making paving blocks and a conclusion as to specification clauses, inspection, etc.

In the article in ENGINEERING NEWS, of Aug. 13, 1914, on "Recent Developments in Granite-Block Paving" (which contained the principal clauses in the new specifications for work in New York City) it was stated that improvements in New York City specifications were largely the products of conferences between the city paving experts and the quarry men, and of several inspection trips made by the city engineers to various quarries in New England and elsewhere. In the following columns we have endeavored to bring out such features of the work of making granite paving blocks as are of interest and value to the city engineer who has not had the advantage of a quarry trip in drawing his own specifications.

HISTORICAL

Split granite paving blocks (made of Quincy granite) were probably introduced in this country in Boston by Solomon Willard in 1840. These were large slabs about 18x14x12 in., but subsequently the size was reduced to about 1 ft. square. A few years later dressed-stone blocks under the name of "Russ" blocks were introduced on lower Broadway, New York City.

FIG. 1. GRANITE BLOCKS AS THEY COME FROM THE QUARRY; MAKING THE FIRST SPLITS

Russ obtained a patent in 1846 for a granite-block pavement on a concrete foundation 8 to 10 in. thick, cast in the form of slabs, with eye-bolts for convenience in handling. The foundation panels were designed to be lifted off the subgrade to provide access to sewers, gas and water pipes, etc. The pavement consisted of granite or syenite blocks averaging 10 to 12 in. long, 4 to 5 in. wide on top, and about 10 in. deep, carefully laid, the ranges of stone forming lozenge-shaped divisions, presenting the edges diagonally to the wheel tires. The patent rested on the scheme of foundation by slab units. This type of pavement cost $5.50 per sq.yd. It did not give satisfaction, for one reason because the surface of the blocks was too large to give a good foothold for horses.

These pavements were replaced by "Guidet" blocks, which were of granite, "equal in hardness to Quincy granite" (which is about the hardest), from 3½ to 4½ in. in width, from 10 to 15 in. in length, and not less than 8 in. or more than 9 in. in depth. These blocks were set on the smallest face, lengthwise across the street. The ends of the blocks were dressed so as to give close joints in the direction of traffic, but the broad vertical sides of the blocks were left ragged and uneven, so that the longitudinal joints across the street were quite wide and open. These pavements cost $4.75 to $5.25 per sq.yd. on a sand foundation. On a concrete foundation the cost was $1.10 to $1.50 per sq.yd. more.

About the same period the so-called Belgian blocks were introduced. These were rough cubes of stone, those in New York being mostly of Hudson River trap rock. These were also quite extensively used in Boston about 1856. They were not less than 5 in. nor more than 7 in. in breadth, not less than 5 in. nor more than 6 in. in width, with a depth of between 6 and 7 in. These were laid either on sand or concrete foundations, with sand-filled joints, and cost about $4.50 to $5 per sq.yd.

Although some Belgian-block pavements still exist in New York and other cities, their use was displaced by the rectangular block 4 to 4½ in. wide, 9 to 11 in. long and 7 to 9 in. deep. Pavements of these larger blocks form the majority of the older street surfaces in all our large cities, and their use was continued for many years—in fact, they are still being laid in many cities.

It is only within the last six years that a successful effort has been made to build granite-block pavements as free as possible from the old defects of noise and uncleanliness by specifying smaller and more regularly-shaped blocks. Reducing the depth of the blocks helps, for there is, of course, less chance for irregularity and unevenness in a block 5 in. deep than in one 9 in. in depth; but the greatest step was getting away from the use of nothing but the hardest obtainable granites; for the softer, finer-grained granites not only split more easily and regularly, but have been found by experience to make a better wearing surface.

This has led to the development of quarries for paving-

FIG. 2. BLOCKS AS THEY COME FROM THE QUARRY

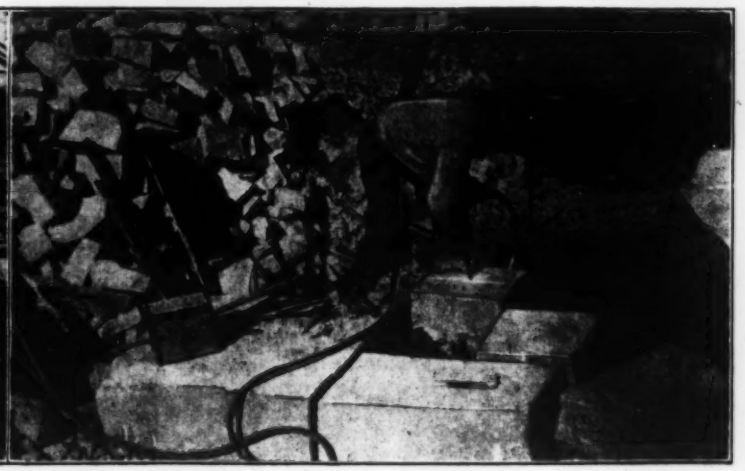


FIG. 3. QUARTERING THE LARGE BLOCKS WITH PNEUMATIC HAND DRILLS, PLUGS AND FEATHERS

block manufacture only, and instead of being a side issue of the quarryman's industry paving-block manufacture has become an important industry of itself. A few years ago a paving-block quarry was called a "motion," in derision of its being a temporary affair. The qualities demanded of granite for good paving blocks may be materially different from those of a good building or monument stone, and this is at last being appreciated.

STRUCTURE OF GRANITE

Granite is composed chiefly of quartz, feldspar and generally mica. Quartz is considerably harder than steel and feldspar is almost as hard as steel, so that granite composed wholly or almost wholly of these two minerals is hard enough to make cutting with steel tools very difficult. Mica, on the other hand, being soft and absorptive, has always been considered objectionable if existing in a relatively large amount.

The exact proportions of the three minerals cannot easily be determined, for a chemical analysis gives the proportion of chemical elements only. Inspection and

FIG. 4. DRILLING HOLE FOR A "BULL WEDGE"

FIG. 5. SPLITTING BY SINGLE BLOW ON "BULL WEDGE"

FIG. 6. MARKING LINE OF FRACTURE FOR BREAK INTO TWO-BLOCK SIZES

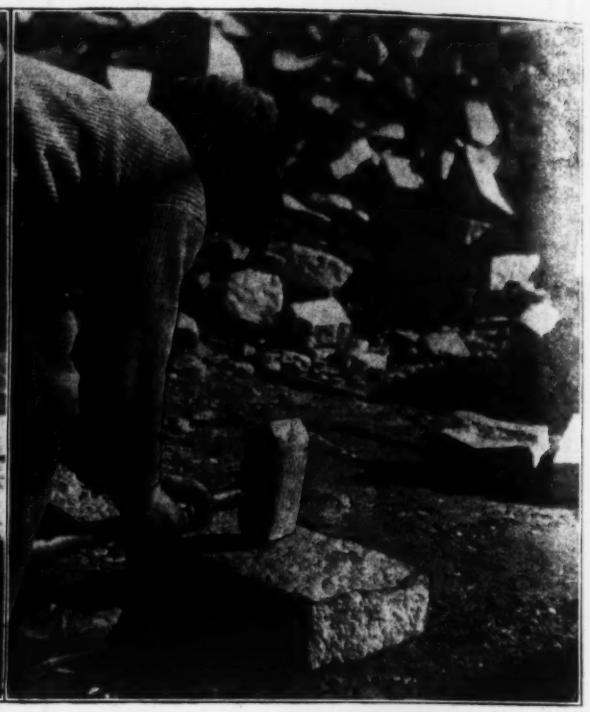


FIG. 7. BREAKING BY STRIKING WITH FLAT FACE OF HAMMER OPPOSITE CUT

microscopic examination are about the only practical tests which have ever been applied to determine the mineral elements of the stone. Coarse-grained stone with knots of feldspar or quartz are to be avoided for paving work. The usual specifications call for a granite free from an excess of mica or feldspar, yet the part, good or evil, that these minerals play has never been scientifically studied.

By experience it has been found that granite splits more easily in two planes than in other directions. These planes are those of the *rift* and the *grain*. These are obscure microscopic foliations, inclined at an angle of 90° to each other. Blocks split easiest along the rift, next along the grain, and some granites fairly well in planes at right angles to both of these. Rift influences the crushing strength; the ultimate strength is greater when applied at right angles to the rift than when applied parallel to it. The rift and grain are seldom visible to the ordinary observer, but are very quickly detected by the experienced stone cutter. In workable quarries the granite generally lies in horizontal or nearly horizontal strata or sheets, 2, 3, 4 or more feet thick, called by quarrymen *lifts*, pre-

FIG. 8. MARKING OUT THE SINGLE BLOCKS

FIG. 9. BREAKING INTO SINGLE BLOCKS

FIG. 10. FACING UP BLOCKS WITH HAMMER

sumably because one stratum may be readily separated from the other by mere lifting.

Quarrying

There are many problems entering into the successful quarrying of granite which call for capital, practical experience, geological knowledge and mathematics. In developing a new quarry the first step is the exploration of the surface to determine the extent of the stone, the character of the jointing, the presence of headings, dikes and veins and frequency of knots.* To accomplish this considerable stripping has to be done, and the lift, rift and grain determined. Core drilling is necessary to discover the thickness of the sheets and the character of the granite. A quarry site has to be selected and locations for dumps provided, as well as facilities for drainage and transportation. Very much experience and judgment are required in the use of explosives or the blocks are so shattered as to be useless.

The old methods of drilling and blasting formerly applied to all classes of rocks are now done away with, except in the case of the very hardest and toughest stone, like trap rocks, which are used only in irregular fragments for road metal. Where blasting has to be resorted to with granite, it is the custom to drill a series of small holes along the line the stone is to be broken, and to charge these holes with light charges of black powder. The holes are fired simultaneously. In this way the force of the explosion is distributed over a considerable area and shattering of the material avoided. With softer stones than granite, channeling machines are now used.

For quarrying granite the type of drill used is the steam or air cylinder drill mounted on a tripod. Most of the drill holes are used not for blasting, but for what is known as plug-and-feather splitting. The drill holes extend nearly through the lifts. In these are placed thin steel plates, called feathers, to protect the sides of the drill holes. Between the feathers steel wedges or plugs are driven along the whole line, as nearly simultaneously as possible. In this way huge blocks are detached. Where the lifts are too thick to be split through, other methods have to be used to separate the blocks from their beds.

The blocks to be loosened must be (1) bounded laterally by two free ends (consisting either of two artificial channels or two joints, headings or dikes, or else one of these and one channel) and bounded the other way by one quarried face and the desired line of fracture; or (2) bounded laterally by one channel and the proposed line of fracture and the other way by a heading or joint and a free face; or (3) not bounded laterally by any free end and the other way only by the working face. In this case after the fracture is made the other two sides of the block must be cut either by blasting or splitting. In all these cases the boundaries of the block are the upper and lower surfaces of the sheets or lifts, and the lines of fracture must follow either the rift or the grain. Where the grain is weak it requires double the number of holes to effect a fracture along it than along the rift.

Fig. 11. General View of Quarry of J. Leopold & Co., Vinal Haven, Maine; Showing Sheet Formation of Granite

The blast holes are usually called "lewis holes." They consist of two or three contiguous holes with intervening rock chiseled out, or where less force is required, "knox holes," which consist of a circular drill hole with two diametrically opposite lateral vertical grooves. The drill holes may be divergent below.

The "channels" are about 4 in. wide and are made either by drilling blast holes in zigzag order, which are fired singly in diagonal order, or by drilling holes on both sides of the proposed channel in close order; or else the channel consists of a single row of contiguous drill holes. This practice is found more economical with granite than the use of a channeling machine. In some instances, notably in the Long Cove quarry of the Booth Bros. &

*From Dale's U. S. Geological Survey Bulletin No. 354.

FIG. 12. TYPICAL YARD SCENE, SHOWING COMPRESSOR PLANT IN THE BACKGROUND

Hurricane Island Granite Co., mining methods with shafts and tunnels are required to loosen the overlying rock.

After a large block is loosened it is broken up into smaller blocks by splitting. This is done by drilling rows of ¾-in. holes about 4 in. deep by means of pneumatic hand drills. Every few feet a deeper hole is drilled. Splitting is done by driving plugs between feathers as previously described.

The size of the blocks delivered to the paving-block cutters varies somewhat with conditions and in the different quarries. At the Rockport, Mass., quarries of the Rockport Granite Co., the blocks are mostly between 2 and 3 ft. square. At the Vinal Haven, Me., quarries of J. Leopold & Co., where the accompanying views were taken, the blocks are often 4 or 5 ft. square.

At Vinal Haven these blocks are delivered to the block cutters by cable railways. The blocks are lifted out of the quarry by derricks directly to the cars, which, by means of cable lines, are run to any part of the yard. The yard is arranged in alleys fronting the railway track. Between each two alleys is a compressed-air supply pipe, with a connection which serves for four cutters. All drilling in the yard is done by small compressed-air hand drills. The men split the blocks with hand tools furnished by the company, at so much per 1000 blocks. The working capacity of a cutter varies from 150 to 200 blocks per day, and he earns $18 to $30 a week.

The blocks are quarried in multiples of 19 or 20 in., measured along the rift. This is four paving blocks deep, with an average depth of block slightly less than [illegible] (specifications call for a depth of not less than [illegible] or more than 5¼ in.).

In splitting the large blocks into smaller units [illegible] so drilled that longest splits always come along the rift. Fig. 1 shows the initial step in splitting a large block with plugs and feathers. In this case the thin slab is approximately 8 in. wide (width of two blocks not less than [illegible] or more than 4½ in. wide.)

These large slabs are generally quartered, the cross split being along the grain—the vertical plane at right angles to the rift. Figs. 2 and 3 show how this is done by means of a "bull wedge," which is a short, stubby wedge driven into a single drill hole. First, however, the line of fracture is cut into the top of the block by a chisel-edge drill to a depth of about ¼ in. (see Fig. 3).

The quartering continues, as is shown in Figs. 4 and 5, until a slab is obtained which will make eight blocks (Fig. 5). Practically all this splitting is, of course, done along the rift and grain, and by means of bull wedges. When a block is obtained which will make four paving blocks, drilling is no longer necessary, but the line of fracture is simply marked by a hand chisel in a light cut across the rift, as shown in Fig. 6, and then the block is turned over and struck opposite the mark with the flat face of the hammer (Fig. 7), which ordinarily gives a good, clean fracture along the grain. The last break into the two paving blocks is shown in Figs. 8 and 9.

The final step is accomplished as shown in Fig. 10, when any rough places are knocked off by a rectangular hammer having a square flat face. The cutting is done by the edge of the hammer. When finished the sides of the block, ordinarily, are the rift, the ends are the grain and the tops and bottoms are surfaces split across both the grain and rift, and are consequently subject to the greatest unevenness and imperfections.

The procedure outlined is that ordinarily followed at the quarries of the Rockport Granite Co., of J. Leopold &

FIG. 13. LOADING DOCK AT LOW TIDE, SHOWING SKIPS READY FOR DUMPING IN SCOW

Co., and of the Booth Bros. & Hurricane Island Granite Co., which furnish a large part of the granite used in New York City work.

The illustrations were taken at the Vinal Haven quarry of J. Leopold & Co., which was opened in 1911. The stone here is a very remarkable granite, of a light gray color, which splits in all three planes with almost equal facility. Figs. 11, 12 and 13 show some general views of this quarry. Since it was opened three years ago 10,000,000 blocks have been made there and shipped to New York City. This quarry employs about 100 men getting out stone and 160 block cutters. Nothing but paving blocks are made. The other two companies operate a number of quarries and also turn out granite for building purposes.

All these quarries are located on or near the ocean front and for this reason have admirable transportation facilities to all the Eastern seacoast cities. From the yards the blocks are generally loaded on railway cars or wagons, in skips which may be lifted off by derricks and dumped into the holds of scows and schooners. This handling of the blocks, by the way, furnishes a very fair abrasion test and any blocks of inferior quality granite are likely to be discovered.

FIG. 14. BLOCKS PILED FOR SHIPMENT; VINAL HAVEN QUARRY OF J. LEOPOLD & CO.

CONCLUSIONS

From the method of manufacture as outlined it is clear that it would be impracticable to specify blocks which will lay closer than with ⅜-in. joints, the specified maximum of the New York City specifications. Joints of ¼-in. are often specified, but this is absurd and cannot be enforced.

The granite which makes the best blocks both in shape and wearing qualities is a fine, even-grained granite, not necessarily of the hard varieties. The ability to obtain flat-sided blocks varies much with the granite used, that from some quarries being split on very regular planes at a minimum expense of cost and labor, while there are some stones which cannot be split at all regularly.

If close joints and bituminous filler are specified it should be known in advance that the quarry from which the blocks are to be obtained is able to produce this kind of material; but where bituminous filler is not used, the experience of Worcester, Mass. (see ENGINEERING NEWS, Oct. 22, 1914) and other New England cities proves that excellent pavements may be made with blocks of soft, fine-grained granite, with joints ½ to ¾ in. wide, filled with cement grout.

Granite is worked much more easily in warm weather than in cold. Freezing weather seriously affects the ease of splitting and the regularity of the breaks. Under any and all circumstances rougher faces on the top and bottom of the blocks are to be expected than on the sides and ends, which are split, as explained, along the rift and grain.

The method of paying the block makers for their work tends to put quantity ahead of quality and hence a careful inspection of blocks is essential. This inspection work should be done by a practical quarry man, for with his experience his eye quickly detects imperfect and under- or over-sized blocks. Where large quantities of blocks are to be used the inspection should be at the quarry, for this will save money both to the city and the contractor; then after the blocks are on the work they need be examined for imperfections incurred in shipment only.

The study of the historical development of early stone-block pavements shows that the present pavements, costing from $4 to $4.50 per sq.yd. in New York City, are by no means exorbitant in first cost, for first-class granite-block pavements. In this city the cost of stone-block pavements of much inferior quality has always been practically as much or more.

Granite Block Paving with close joints is the only satisfactory pavement for use between the rails of car tracks, says Henry Welles Durham, Chief Engineer of the Bureau of Highways of Manhattan, in his annual report, based on study of experience in all parts of the world. While such pavements laid under the rigid specifications now in force in Manhattan are expensive in first cost, the maintenance is far less than the older types of pavements which have to be constantly overhauled. The New York Railways Co. has during the past year adopted the practice of using close-jointed granite-block paving in all its repair work.

The Effect of Architects' License Laws upon Engineers

By an Illinois Engineer

The concerted movement made by architects to secure license laws in all the states of the Union is fraught with consequences to engineers which should not be ignored. Beginning with the passage of a law in Illinois in 1897, the movement spread to New Jersey, California and Colorado. A number of other states are now considering the adoption of similar laws, and their passage is being urged by the architects.

Some of the older architects in Illinois say the Illinois law was suggested by the advent of the steel-frame and reinforced-concrete buildings. These forms of construction called for ability in designing not possessed by many architects and made them peculiarly dependent on structural engineers. It was considered that there was danger of the profession of architecture being swallowed up by engineers, the men trained in architecture being employed as draftsmen by engineers. At the outset trouble was encountered from the engineers who were then making a specialty of structural work, and a clause was inserted to take care of them. Applicants for licenses during the first six months after the passage of the act were not compelled to pass an examination.

Section 9 of the act defines architects in the following language:

> Any person who shall be engaged in the planning or supervision of the erection, enlargement or alteration of buildings for others, and to be constructed by other persons than himself, shall be regarded as an architect within the provisions of this act and shall be held to comply with the same * * * The term building in this act shall be understood to be a structure, consisting of foundations, walls and roof, with or without the other parts * * * nor shall a civil engineer be considered as an architect unless he plans, designs and supervises the erection of buildings, in which case he shall be subject to all the provisions of this act, and be considered as an architect.

Under the provisions of this section defining an architect, practically all the civil engineers then in private practice who were specializing in structural design took out licenses as architects. This definition makes it necessary for structural engineers who wish to work without being in the employ or under the control of architects to pass the examinations which are held in April and September of each year.

For a number of years it was not uncommon for engineers to pass the examinations and receive licenses. The general average required for passing is 70, which made it comparatively easy for engineers to pass. Many men passed, however, who were not as good architectural draftsmen as the architects wished to see in active practice, so in October, 1909, the board of examiners made a ruling that "no license shall be issued to those having taken the class examination unless their marks or averages on each division of the examination shall be 60 or more."

This rule has brought matters to a crisis. The work of the first day of the examination, which lasts three days, is the working out of a problem in the architectural planning of a building, including the drawing of elevations, etc. In 7½ hours the candidates are required to do all the work ordinarily occupying several days or weeks in the office of an architect in private practice. Good draftsmanship is essential, the language of the board rule being as follows:

> One day shall be devoted to ascertaining the ability of the candidate to make practical applications of his knowledge in the ordinary professional work of an architect, which will include an effort toward ascertaining the qualifications of the applicant in draftsmanship and the art of planning and rendering.

The adoption of this rule by the board has materially cut down the number of engineers who qualify, for ornamental architectural drafting is not taught in engineering schools.

To show the absurdity of claiming that the work of the first day is a test of the candidate's ability to "make practical application of his knowledge in the ordinary professional work of an architect" it is only necessary to say that *no experience is required*, many of the candidates in the April examinations being seniors in architectural schools, some of whom receive a license to practice architecture before they graduate.

On the afternoon of the second day, half the time is given to architectural definitions, discussions on architectural styles, questions on architectural history, etc. The remainder of the afternoon is devoted to the analysis of a roof truss.

Engineers are excused from no part of the examination, but graduates of certain architectural schools are excused from the work of the third day, which is the day devoted to the designing of the structural framework of a three-story building in part: i.e., certain beams, girders, floors and columns in this building are selected by the examiners and the candidates determine the sizes. Any graduate of an architectural school who cares to get a mark of 70 on the third day may get it and omit the written examination. A great many claim this exemption, the writer knowing several who were afraid to take this simple examination in elementary structural design, their work after leaving school being exclusively artistic architectural planning and design.

This exemption of students in architecture from an examination in the very subjects which were urged on the Legislature as being essential and the refusal to exempt engineers who are specially trained in these subjects tend to make the law farcical. Instead of operating to safeguard the public, it operates to make architecture a closed profession. Engineers think that graduates in architecture, if exempt from any part of the examinations, might properly be exempt from an examination in draftsmanship, architectural history, definitions and development, because their training is forced along such lines; whereas, if licensed architects are to have positive control of building design and construction, they should certainly be competent to take an examination in structural design. Complaints of a similar nature come from other states where architects are examined for licenses.

In a recent canvass by the Legislative Committee of the Western Society of Engineers, many hundred men were found practicing structural engineering, the majority of them graduates of high-grade engineering schools, who complained about the restrictions imposed on them by the architects' law. As a result of this canvass a law has been prepared permitting structural engineers to be licensed to construct buildings and its passage will be urged at the present session of the Legislature.

The general question of licensing engineers has nothing to do with the present work of the structural engineers in Illinois. Possibly a majority are not in favor of such laws; but at present it is a condition and not a

theory which Illinois engineers are facing. To place the positive control of building design and supervision in the hands of architects and bar engineers from such work is not just to engineers and is not fair to the public. The feeling of security given to the public by the stamp of a licensed architect on plans is fraudulent in many cases, especially where the architect secured his license without examination because he was practicing when the law was passed.

Engineers admit that there is much more than structural design in a building; but the interest of the public in the police laws of a state cannot possibly extend to the points on which architects lay most stress, that is, planning and beauty. Housing is regulated by housing laws and any intelligent engineer is fully capable of providing space for stairways, light courts and other items mentioned in housing regulations. Plumbing plans are usually made by practical plumbers, following closely the regulations made and provided by the municipal authorities. Ventilation is an engineering problem. Therefore the difference between the work of architects and engineers in the design of buildings is that architects attempt to build for beauty and engineers to build for safety.

A comparison of the courses of study in schools of architecture and of engineering will show who is most competent to be intrusted with the design and construction of buildings from the standpoint of safety. All large architectural firms employ structural engineers to design the framework of important buildings. Numbers of structural engineers maintain offices where they do engineering work for architects who do not do enough work to employ engineers on salary.

It is believed that the Illinois architects will try to prevent structural engineers obtaining the right to design and supervise the construction of buildings except under the supervision of architects. Regulation of trades and business by law is popular with the public. It is advisable that engineers in other states take warning from Illinois and act before it is too late.

Water and Other Utility Service Standards of the Railroad Commission of Oregon

The Railroad Commission of Oregon, acting as a general utility commission, has formulated standards of service for water-, gas- and electricity-supply companies in that state. Other regulations for the telephone, gas and electric companies have been formulated in other states (for Wisconsin, see ENGINEERING NEWS, Oct. 8, 1908, Nov. 12 and 26, 1914; for Illinois, Dec. 10, 1914), but this is thought to be the first attempt to prescribe operating standards for water-supply utilities. The regulations are divided into two parts, general and special. The general requirements demand testing facilities; available records of all tests; free meter tests for customers once a year on request; meter tests by the Commission on application, the cost of which is assessed on the customer or the company according as to whether the meter is slow or fast (3% for gas, 4% for electricity, 2% for water); adjustment of old bills for fast or slow meters, the allowance of required deposits against current bills not to exceed estimated thirty-days' bill for customers not paying in advance; no deposits allowed from a customer to cover cost of installation, except by approval of the Commission; no rental for meters; records of interruptions of service and complaints; coöperation with customers in securing lamps and appliances adapted to the service:

The special rules for water service are as follows:

Rule 27. Purity of Water Supply for Domestic Purposes—Each water utility delivering water for domestic purposes shall furnish a supply which shall at all times be free from injurious physical elements and disease-producing bacteria, and shall cause to be made such tests and take such precautions as will insure the constant purity of its supply. A record of all tests and reports pertinent to the water supply shall be kept in accordance with Rule 3.

Rule 28. Adequate Pressure Required—Each water utility shall always maintain sufficient pressure at the end of its services to supply adequately each customer connected, except customers who have specifically agreed to permit interruptions of service.

Rule 29. Meter Testing Equipment—Each water utility supplying 300 or more customers through metered service shall install and maintain a meter tester of a type satisfactory to the Commission.

Rule 30. Installation Tests—Each meter shall be tested for accuracy before its initial installation, and no meter shall remain in service longer than three years without being retested.

Rule 31—Allowable Limits of Variation of Meters—No meter shall be installed or replaced in service if it registers more than 102% or less than 94% of the water passed on full capacity, or more than 102% or less than 85% on one-sixteenth capacity.

Rule 32. Fees for Tests—The following fees shall be paid by any customer applying to the Commission to make test of his meter, as provided in the second paragraph, of Rule 5, viz.:

For each meter not exceeding 1-in. capacity	$2
For all other meters	5

Rule 33. Pressure Surveys—Every water utility supplying over 300 customers shall have a recording pressure meter which shall be kept in continuous service on the system at some point approximating the elevation of the center of distribution of the district served, and shall indicate on the graphic records such elevation and causes of extreme variation in pressure. Such records shall be open for public inspection.

The special rules for gas demand a monthly average total heating value of not less than 600 B.t.u. per cu.ft., within one mile of the manufacturing works. Companies making over 10,000,000 cu.ft. per year must have a standard calorimeter outfit and test on three days per week. Gas may contain 25 grains of sulphur and 5 grains of ammonia per 100 cu.ft., but no hydrogen sulphide shown by lead-acetate paper. Meters must be correct within 1%; no meter may remain in service more than 60 months without testing. Pressure must not drop below 2-in. water head and never be greater than 6 in., without approval. Variation of pressure must be no more than 2 in. One recording pressure gage is to be installed in each pressure district, with a minimum of two gages.

The special rules for electricity-supply service require meters to be accurate within 1% at three-quarters and one-tenth rated capacity. Small single-phase induction watt-hour meters must be tested once in three years. Large single-phase induction meters (of over 50-amp. capacity) and small polyphase or commutator meters must be tested once every 12 months; all others once every six months. In places of over 1500 population, a standard voltage must be adopted for each constant-potential system; in any lighting district, this shall not vary for over five minutes by more than 3% above and 5% below, between sunset and 11 p.m. At other hours 5% and 10% variation is allowed on lighting lines; on other circuits 10% above or below is permited. A company having over 250 customers must have two recording voltmeters and make surveys on such feeder, one meter being in continuous use.

A Unique Problem in Valuation; Inheritance Tax Appraisal of the Hales Bar Hydro-Electric Plant

By Louis L. Tribus*

The descriptions of the completed Hales Bar hydro-electric development near Chattanooga, Tenn., in Engineering News (Nov. 13 and 20, 1913) marked the completion of this most interesting work. Now a second phase can be presented, and some years hence other chapters may need to be written.

The late Anthony N. Brady, chief projector of the enterprise, advanced practically all the money required—without marketing any securities or even making complete provision for their issuance. Mr. Brady died before completion of the plant, leaving his undetermined interests in the venture as an asset of his estate. To the Comptroller of the State of New York came the duty of assessing the various assets for inheritance tax purposes. Most of the other extensive holdings of this astute promoter and financier had sales values, or established earning power, or quite tangible physical worth. But the Hales Bar plant lacked nearly every usual element required for valuation and presented a most unique problem.

To show the absence of tangible data on which to predicate real property values, upon which to base an inheritance tax, a review of the development conditions is necessary.

The original plan contemplated an entirely different site from that finally selected; yet the construction difficulties were still not sufficiently foreseen as later events proved. The license to build and operate was secured from the Federal government, under provisions of the act governing use of navigable streams, subject to certain conditions: (1) Erection of a structure according to plans approved by the War Department; (2) changes in design from time to time as might be required by the Army Engineers; (3) construction of a navigation lock and furnishing operating power therefor; (4) continuously passing the minimum river flow; (5) establishing a pondage level. The license was for 99 years without renewal stipulations, the presumption being that the plant would pass to the government. Chattanooga granted a franchise to sell electricity, the term aggregating, with two renewals, somewhat less than that of the Federal license.

There existed in Chattanooga steam plants aggregating, perhaps, 25,000 hp., not including street-car service. Mr. Brady and his associates expected to secure a large part of this steam-plant load and to supply the street railway, thus finding use for the whole normal wheel output at Hales Bar. The flood flow could be utilized, if the demand justified, with a steam-station auxiliary. Large tracts of land in the vicinity, suitable for manufacturing sites, were secured, but at Mr. Brady's death little tangible development could be certified as affording an immediate market for energy.

An original expenditure of about $3,000,000 was contemplated, the plant to be in use by 1909 at the latest, allowing four years for construction. But floods and washouts, litigation, successive sets of contractors, extensive changes in cross-section of dam and in depth and character of foundations, etc. (made necessary by unforeseen river-bottom conditions and requirements of the Army Engineers) dragged out construction until the latter part of 1913, and entailed a gross expense of over ten million dollars. Interest account formed its part of the larger sum. A rival company developed a plant on a branch of the Tennessee River and secured some of the ready business, while other companies strengthened their occupancy of neighboring cities.

Credit must be given to the sheer pluck and grit, and desire to keep his pledged word, that led Mr. Brady to advance million after million with eventual failure apparently in sight. It did seem like pouring gold through a coarse sieve into a bottomless pit. Yet the wide interests and power of Mr. Brady and his associates must be kept in mind as a factor for ultimate success where smaller operators might well have faced complete failure under adverse events. It may well be imagined that strong efforts will be made to secure the location of manufacturing plants on the lands held. It undoubtedly occurred to the promoters, during the later operations, that a consolidation of power interests in the locality might bring some measure of rescue and advantage. But, aside from throwing light on reasons for continuing to spend, such matters could have no weight in a valuation.

This, then, was the situation faced by the Comptroller of New York. To approach the problem, Charles M. Friend was appointed appraiser, with Eugene Lamb Richards, Jr. (now Superintendent of Banks) as counsel, and the writer's firm as engineering advisers to counsel. (C. R. Bettes and the writer handled active court work and C. G. Massa the gathering and compilation of the large amount of data required upon which to base deductions and conclusions.) For the Brady estate, Samuel A. Beardsley was active counsel, John Bogart, consulting engineer, and Thomas E. Murray, special representative and electrical engineer. (This plant was designed and built under Mr. Bogart's direction.)

Summarizing and using round figures only, the situation before the appraiser was as follows:

PROSPECTS IN 1905

Proposed investment—three millions;
An available market;
Contracts pending;
Good chance for new industries on neighboring lands;
Construction three to four years.

CONDITIONS IN 1913

Total expense over ten millions;
A partly lost market;
Construction period nine years;
Death of promoter and owner before completion of plant, or culmination of allied schemes.

PROBLEM FOR APPRAISER

What was the fair value of the Hales Bar plant at time of Mr. Brady's death?

Before giving the matter full consideration, counsel for the estate rather inclined to agree to four million dollars as a satisfactory figure, but withdrew to a much lower sum before testimony was taken.

With present hindsight knowledge used in advance, the able engineers and final contractors could probably have built the plant for rather less than five million dollars and within four years' time. Had the Chattanooga market for current remained open, with fair chance at other neighborhood business, earnings might well have been secured on an investment of that sum. Had securities been issued, keeping pace with construction, the sales prices would have furnished some criterion of value. But only the original issues were agreed upon and

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they were virtually held in escrow, and gave no clue other than their face totals. Had a transfer of interests been effected, there would have been some figures for consideration, but an unsecured furnishing of money took place, though protected, of course, by majority holding of the original bonds and stock. Finally at Mr. Brady's death the works had no earning value (and only potentially later, through possible completion with moneys not at the time fully provided) and, so far as evidence was presented to the appraiser, no prospective business contracts of any moment.

In a sense, therefore, the plant had no value, so far as earnings in sight were concerned, and it could not under any circumstances earn adequately on a ten-million-dollar basis. Furthermore, the flow of the river and pondage cannot provide a larger power than that planned for, without steam auxiliary (a feature which could not be considered under the conditions of the appraisement).

Jacobs and Davies, engineers and the latest contractors, testifying for the Brady estate, presented arguments all tending to deny any existing or prospective market for the power, therefore in effect showing little but a salvage value for the plant, though not expressing it in just so many words. They dwelt largely on misfortunes during construction as a reason for low valuation as a taxable asset.

It was not denied that the Brady estate would attempt to develop a market in the future and had no intention of abandoning the project.

Witnesses for the state, though recognizing the loss of much of the existing market, believed that business could be developed beyond that existing and not secured. Through a consolidation with neighboring power companies and the bringing of new industries into the field, sales should be possible on such a scale as to warrant an investment of five to six million dollars. As earlier intimated, the reproduction cost would be about five million dollars, or less. Considering possible lack of complete success in such later business ventures as would have to be attempted, four to five million dollars was not thought an unfair value by the witnesses for the state, and under some views even perhaps more.

The appraiser (in November, 1914) has placed $3,200,000 in his schedule as in his judgment a fair value for the purpose in question.

No ordinary rule of law or scheme of valuation could set a figure which could be pointed to as of unquestioned exactness and fairness. The best that could be done was to summarize facts of actual expense and possible reproduction cost, to surmise as to original estimated earnings, possible hydraulic output and earnings if the current made should be sold, to guess as to new industries which might use the power, to guess as to killing off competition through possible consolidation of interests (quite feasible and desirable), to guess as to how much the estate would be willing to throw away in a deal for sale, and to make some fair reduction from a final derived figure to represent possible slip-up in carrying out the plans for new business.

It also had to be borne in mind that for immediate earning purposes the plant was substantially worthless, at the time of the death of Mr. Brady (for which date the valuation had to be made), for being incomplete it was not ready to earn a return. At the same time it would be an absurdity to certify that the plant had no value for taxation purposes, any more than an unfinished house should not be considered of value to an estate because not ready for a tenant.

All these conditions and arguments, and perhaps others, had to be reviewed and be given much or little weight as the appraiser felt proper. Several months were taken in the gathering of data, preparation of estimates and taking of testimony, and abundant time after the case was closed for considering the decision. The case was conducted without bickering and the greatest possible latitude given for the admission of testimony.

However, according to the daily press, the Brady estate claims great injustice in the decision rendered and proposes to contest the matter in the courts. The case is unique in valuation work and its further history will be followed with great interest, not only from the viewpoints of engineering, but for the legal principles that may be involved and later promulgated.

Paving for Park Roads

The present and proposed methods of paving the driveways in the public parks at Springfield, Ill., were described in a paper read at the recent annual meeting of the Illinois Society of Engineers and Surveyors (at Springfield) by G. L. Harnsberger, Chief Engineer of the Pleasure Driveway and Park District. The local soil is black earth in the valleys and yellow clay in the hills. For about two years the District has been using burned shale from the waste dumps at the coal mines. This takes fire and burns in the dumps, and is similar to burned-clay ballast (ENGINEERING NEWS, Jan. 21, 1915, p. 103) but is not so thoroughly burned. It burns to a dark red color, which gives an attractive appearance to the roadways.

At first this was laid 4 to 5 in. thick on the rolled subgrade, but much of it (not being hard burned) disintegrated, while in the gutters it would not stand the rush of water. Brick gutters are now used, therefore, and a 6-in. bed of clean hard cinders is put beneath the shale to facilitate drainage. It must be sprinkled in summer, and even when calcium chloride is used (in crystals or in solution) an occasional sprinkling is necessary in hot dry weather.

The mines are not now bringing this waste to the surface, but are using it to pack the empty rooms after the removal of the coal. Macadam, brick and concrete are too expensive, and it is proposed to try oiled gravel, as used in California and at Kansas City. Some of the new railways have been given a good bed of cinders, 6 in. thick after being wetted and rolled. The plan is to cover this with 3-in. of gravel and sand, sprinkle it with crude oil and roll it. The surface would be finished by applying a light coat of torpedo sand and a light sprinkling of oil, and then given a final rolling. After being in service for a time another coat of oil might be applied.

A Concave Street Surface with Central Gutter was suggested by W. G. Kirchoffer, of Madison, Wis., in a paper read at the recent annual meeting of the Illinois Society of Engineers and Surveyors, at Springfield, Ill. His design showed a drop of 4 in. at the curb and 10 in. at the center of a 46-ft. street, as against 6-in. curb gutters with the usual arrangement. In residence districts a curb might not be needed, as the parking could be sloped to the edge of the street. The arrangement is already in use for alleys and driveways. The advantages claimed are greater capacity for storm water, facility of cleaning, convenience of establishing street grades, reduction in number and cost of catch basins and sewer connections, and division of traffic to the sides of the street.

The Presidents of Four National Engineering Societies

SYNOPSIS—For the 22nd consecutive year we publish herewith the portraits of the presidents of the four great national American engineering societies, with their biographies. The date of this publication is somewhat later than in previous years, so that it comes just after the annual meeting of the American Institute of Mining Engineers and makes it possible to publish the portrait of the newly elected President of the Institute, Wm. L. Saunders.

Charles David Marx, President of the American Society of Civil Engineers

By Chas. B. Wing*

For the first time in its history, the American Society of Civil Engineers has chosen as president one of its members residing west of the Rocky Mountains.

Mr. Marx was born in Toledo, Ohio, October 10, 1857. His father moved to this country from Baden, Germany, in '49 along with those remarkable and high minded patriots who migrated to this country at that time. His mother came from Heidelberg later, the marriage taking place in this country. The elder Marx was for many years editor of the Toledo "Express," and served as American Consul at Amsterdam under Lincoln. The son began his education in the public schools of Toledo in 1862-63. He then went with his father to Amsterdam for three years, returning to the public schools of Toledo for the years 1867-71. During the period from 1871-76 he was in Germany studying at and graduating from the Karlsruhe Real Gymnasium. In 1876 he entered Cornell University, graduating in Civil Engineering with the class of '78. He then returned to Germany, entering the Karlsruhe Polytechnicum and passing his diploma examination in the spring of 1881. During the year 1880-81, in addition to his studies, he acted as assistant to Professor R. Baumeister.

During his student days in Germany he took an active part in the student life, was a member of the Rugby football team and formed friendships that have lasted through the years. Among his notable companions during the student days in Germany was Marion Crawford, the well known author. Thus were the foundations laid for the development of the breadth of knowledge, clearness of vision and sympathetic understanding that have so distinguished him in his profession as an engineer and teacher. To the education in the common schools of the United States was added the rigorous mental discipline of the Real Gymnasium of Germany. The technical training of the American Engineering School of the '70's was amplified by the courses in analysis and design of the German Polytechnic. His ability to speak as well as read three languages has enabled him to make the most of international engineering congresses, to renew and extend acquaintances and friendships begun during student days, and to keep fully informed in regard to the science and practice of engineering both at home and abroad.

Recently, in addressing the graduating class of the University of Michigan on the topic of what four years of college life should mean to the graduate, Dr. Angell, the famous former President of that University, especially emphasized the value of associations and friendships.

This principle is clearly illustrated in the case of Prof. Marx. The experiences gained by having to adjust himself to the life and social conditions of four schools in two countries have given him to an unusual degree that broad, tolerant sympathy for and love of his fellow man so necessary in helping young men make themselves.

Returning to the United States immediately after receiving his degree in Karlsruhe, he served as transitman and draftsman on the proposed extension of the Boston, Hoosac Tunnel & Western R.R. on the division between the Genesee River and Niagara Falls, and after completing this work was Assistant Engineer for two years on the Missouri and Mississippi River improvements. During one year of this time he was in charge at Osceola Bar.

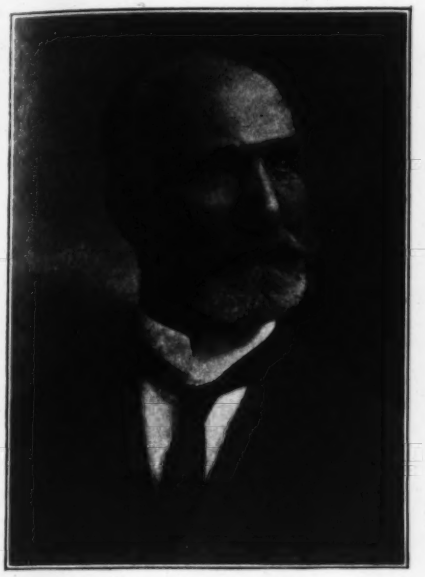
This may be said to complete the probationary period of his engineering training. Returning to Cornell University in the fall of 1884 as Assistant Professor of Civil Engineering, he brought to his work the freshness and enthusiasm of actual achievement. Those of us who were so fortunate as to be in his first small class in elementary designing remember how quickly engineering became a real live question of sound judgment based upon knowledge secured through investigation, critical analysis and thorough information in regard to the work of other engineers and investigators. Under this stimulus the library became a useful tool and the laboratory a place in which to spend every spare hour.

Professor Marx, in undertaking the work of teaching, immediately realized that to make the course effective it must be closely identified with practice, and that the best way to retain the student's interest in the study of theoretical and elementary principles was to show how these principles can be practically applied. As an addition to technical training, he has always been a firm believer in the value of university surroundings for the engineering student and a strong advocate of as much work as possible in the departments of Arts and Science.

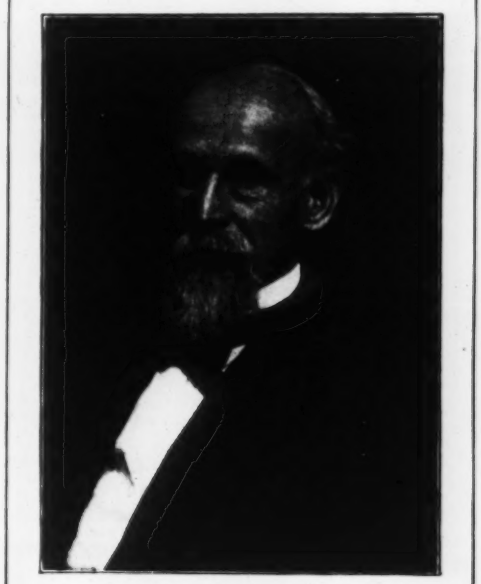
In spite of a heavy and exhausting schedule of instruction he found time to act as Chief Inspector of Public Improvements for Rochester, N. Y., and during vacations as Principal Assistant Engineer to the late Emil Kuichling on the design of the east side trunk sewer for the same city. He also acted during this period, with the late Professor Galbraith of Toronto, as Consulting Engineer for the Smith estate at Trenton Falls, N. Y.

In the fall of 1890, Professor Marx was called to the Chair of Civil Engineering at the University of Wis-

*Professor of Structural Engineering, Stanford University, California.

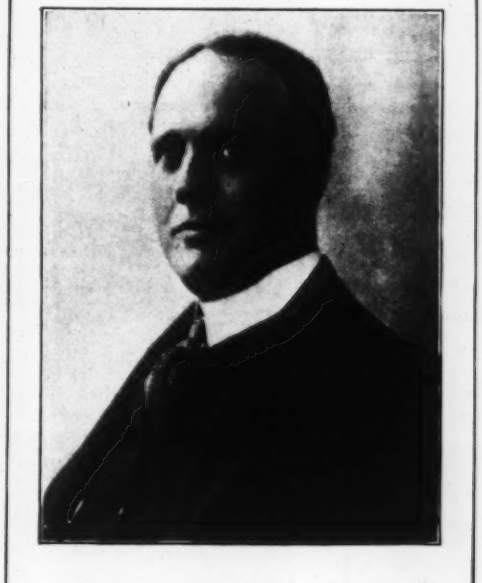


PRESIDENT OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS



PRESIDENT OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

PRESIDENT OF THE AMERICAN INSTITUTE OF MINING ENGINEERS



PRESIDENT OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

THE PRESIDENTS OF FOUR NATIONAL ENGINEERING SOCIETIES

consin. During the year he began the reorganization of the engineering schools, which since that time have continued to grow in strength and usefulness. In the fall of 1891 he was offered and accepted the position he now holds at the head of the Civil Engineering Department of Stanford University.

His removal to California was coincident with the beginning of that great development of this Western country which has taken place in the last quarter century. With some of this work he has been closely identified, especially along the lines of hydraulic engineering for power, irrigation and municipal purposes—the field of his work extending from Colorado to the Coast. As Chairman of the State Water Commission of California, he helped draft the State Water Bill that has just been ratified by the people. This latter piece of constructive legislation, together with the training of the annually increasing body of young engineers consecrated to the task of ameliorating the condition of mankind, is work well worth doing and has been well done.

In bestowing upon Charles David Marx the highest honor within the gift of the Engineering profession in the United States, the American Society of Civil Engineers is placing the seal of its recognition upon one in every sense entirely worthy to receive it. Honor is given and honor conferred.

John A. Brashear, President of the American Society of Mechanical Engineers

By Wm. Lucien Scaife*

John Alfred Brashear is a noteworthy example of the best American type, which harmoniously unites practical ability, inventive genius and intense activity in varied but definite directions with high ideals and warm sympathy for all forms and conditions of human life, as well as for art and nature.

Born at Brownsville, Pa., in 1840, he attended the public schools, and learned the pattern and machinist trades, at a time when steamboat-building was an important industry on the Monongahela River. Later, he became chief millwright of one of the early rolling mills of Pittsburgh. The effect of this admirable training in "quickly applied mechanics" he shows today in solving new and unexpected problems constantly arising at his physical instrument works, as well as in the woods and on the waters of his summer home, and especially on the lecture platform, where his experiments are powerful adjuncts to his convincing eloquence and attractive personality.

His natural bent toward astronomy and science in general was manifested in early manhood by his making a telescope in the evenings which followed the hard daily work of the mill, and using the instrument for celestial observations in spite of the very discouraging atmospheric and industrial conditions of the neighborhood.

This "side-work," however, finally led to an enlarged circle of friends, among whom was the late Prof. Langley, then Director of the Allegheny Observatory, and to the foundation of the now famous shops on the northern hills of Pittsburgh. These works, under the able management of his son-in-law, James B. McDowell, and the adjacent home, presided over for many years by Dr. Brashear's devoted wife, soon became the Mecca of visitors from all ranks and pursuits of life—of scientists seeking advice and instruments, and especially of that numerous body of misguided, would-be inventors who consume much of Dr. Brashear's valuable time, but always find in him a sympathetic listener and friendly adviser.

Not far from his home and works stands the new Allegheny Observatory with its remarkable 30-inch Thaw Refractor, its Keeler Memorial Reflector, and 13-inch refractor that Langley and Keeler used, but which is now devoted to the free instruction and inspiration of the people—due largely to the efforts of Dr. Brashear, who has been for many years a Trustee of the University of Pittsburgh and Chairman of its Allegheny Observatory Committee.

Also a Trustee of Carnegie Institute and a member, since its inception, of the Committee in charge of the Carnegie Institute of Technology, he has been closely identified with the rapid growth and increasing usefulness of these institutions.

As Chairman of the Educational Fund Commission, he has devoted much time and thought to successfully applying the income of an anonymous gift, made through him, to the public, of a quarter of a million dollars for increasing the efficiency of the public schools of Allegheny County. In fact there are but few important movements for civic betterment in Pittsburgh to which he has not lent his aid and inspiration. His abiding love of music and of the beautiful in art and nature is striking proof that scientific and mechanical pursuits, long continued, do not, as has been asserted, necessarily tend to atrophy the aesthetic faculties, but may, on the contrary, help to keep them active and normal.

He has received elections to many learned societies and numerous honorary degrees; but he cares little for these except as they indicate personal appreciation of and sympathy for his constant aim to make human life better, happier and more complete.

*313 Sixth Ave., Pittsburgh, Penn.

William Lawrence Saunders, President American Institute of Mining Engineers

By F. W. Iredell*

The new President of the American Institute of Mining Engineers, William Lawrence Saunders, son of William Trebell Saunders, D.D., and Eliza (Morton) Saunders, was born Nov. 1, 1856, at Columbus, Ga. His boyhood was spent partly at Apalachicola and partly at Key West, Fla., where his father had parishes in succession.

The son received his technical education at the University of Pennsylvania, graduating with many honors from the Mining Engineering Department in 1876. In 1911 his Alma Mater conferred on him the degree of Doctor of Science.

Mr. Saunders was first called to important engineering work in 1878 by the National Storage Co. of Communipaw, N. J., where he had charge of the soundings for the Black Tom improvements. Later he supervised the build-

*11 Broadway, New York City.

ing of warehouses and docks, also the dredging of slips and the ship channel to deep water. In the ship channel he met a difficult engineering problem. For almost its whole length it crossed a reef of exceeding hardness overlaid with gravel and hard-pan. Drilling this material with rock drills in open water was tedious and expensive. The principal trouble was the blocking of the holes with gravel and chippings from the drills. Mr. Saunders devised and patented apparatus which overcame this difficulty. It consisted primarily of a telescoping tube surrounding the drill and resting at the bottom on the rock; and, secondarily, of two jets of water pumped so as to clear the bottom of the drill hole and to eject the cuttings of the drill from the side outlet in the inclosing tube. This apparatus proved a complete success and it has been adopted in most subaqueous operations of magnitude since that time.

Mr. Saunders' success at Black Tom secured for him his appointment as engineer of the Ingersoll Rock Drill Co. in 1881. His first work with the new company was the adaptation of the rock drill to stone channeling machinery. He went to the marble quarries of Vermont and there built, tried out and perfected the Ingersoll track channeler. Afterward he invented the Ingersoll gadder, the bar channeler and machines for sawing and cutting stone; also a coal-mining machine or coal cutter, a quarry bar and a method of driving tunnels by means of a radial stone cutter.

In all between the years 1883 and 1889 he took out fifteen patents on inventions for excavating rock, mining coal and driving tunnels. In 1892 he patented an air reheater and in 1898 an air lift pump.

After the purchase of the Ingersoll Rock Drill Co. by the Sergeant interests in 1887, Mr. Saunders became Secretary and Engineer of the Ingersoll-Sergeant Drill Co. A dozen years later he became Vice-President, and on Mar. 24, 1904, was elected to the Presidency.

In May, 1905, the Ingersoll-Sergeant Drill Co. and the Rand Drill Co. were merged and became the Ingersoll-Rand Co. Mr. Saunders was made president of the new corporation and retained that office until April, 1913, when he was elected Chairman of the Board of Directors.

An interesting history might be written of the beginnings and growth of that department of mining and industrial machinery to which Mr. Saunders has given his life, starting with the rock drill to which Simon Ingersoll, Burleigh, the Githens brothers and Sergeant in turn made important contributions, followed by its adjunct, the reciprocating steam-driven air compressor, and passing on by many stages through a long list of complex and highly technical machines and tools in bewildering variety.

Doubtless his greatest work has been to build up, in cooperation with others, the intensely active, virile and productive organization which he heads and which probably has done more than all other kindred agencies combined to help the mining engineer and the constructor to do his work quickly and cheaply and well. And it is not detracting from the credit for the early upbuilding which is due to that captain of finance and commerce, W. R. Grace, nor from that due the other bright minds in this exceptionally able organization to declare that as a diviner of the future needs of the industry, as a prophet of the value of an invention, as a leader of a sales organization and as a negotiator in large matters, William L. Saunders has no equal in his sphere today.

Mr. Saunders is a member of the American Soci[illegible] Civil Engineers, American Society of Mechanical [illegible] neers, New York Southern Society, New York Chamb[illegible] Commerce, New Jersey State Chamber of Comm[illegible] Mining & Metallurgical Society of America, and A[illegible] ican Iron & Steel Institute.

Besides the Presidency of the American Institu[illegible] Mining Engineers, he is President of the New Y[illegible] Machinery Club, Chairman of the New York Welfare C[illegible] mittee of the National Civic Federation, Chairman o[illegible] Merchant Marine Committee of the National For[illegible] Trade Council, Director of India House, Director of [illegible] International Harvester Co. and President of the [illegible] ternational Harvester Corporation of New Jersey. He was appointed a member of the New Jersey Harbor Com[illegible] mission two years ago.

Mr. Saunders has written many papers and books on rock drilling, compressed air and tunneling, and is editor and publisher of *Compressed Air Magazine*.

Devoted to many friends who in turn are devoted to him, of ripe experience, of superabundant energy, of an enthusiastic temperament controlled by reason, possessing a tender heart and a keen sense of justice and honor, William L. Saunders is doing yeoman service in many industrial, economic and uplifting movements of the hour.

Paul Martyn Lincoln, President American Institute of Electrical Engineers

By Chas. F. Scott*

A sketch of the president of a national engineering society presents the personality of a man who has reached a position of distinction, and it is also significant in indicating something of the type and characteristics of the organization which has chosen him as its leading representative. A comparison of the ages of the last twelve presidents of several of the national engineering societies reveals some significant differences. The average in Civil Engineering is 60; in Mechanical Engineering, 56; in Electrical Engineering, 44. Furthermore only two Presidents of the Civil Engineers have been less than 50 years old; no Mechanical Engineer President has been less than 50; while, on the other hand, only one Electrical Engineer President has been more than 47, and one (the writer) was under 40.

If, instead of total age, we compare the length of years in active engineering service, beginning at, say, the age of 25 or 30, the differences are still more striking. Nevertheless the progress in electrical-engineering development has been so rapid that Mr. Lincoln, whose age corresponds to the average of the electrical presidents, began his engineering work when the electric railway was just beginning to make serious inroads upon the horse car: and he has been in personal touch with power transmission from the days of its infancy.

In its earlier years, electrical engineering had very few men with experience, except in telegraphy. Engineering education of any kind was very meager, and electrical courses were just being established. The magnifi-

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cent pioneer work of the early leaders displayed initiative, resourcefulness and courage, but it was work in the dark. They had to assume or to guess or to find out by costly experience the things which now fill the handbooks. In more recent years the graduates of engineering schools have come to the front, and most of the larger and newer problems have fallen to them. Electrical Engineering has advanced so rapidly that it is unique in the change in its leadership. Young men come to the front. Of the twelve recent presidents of the American Institute of Electrical Engineers, nearly all are graduates in engineering courses of technical schools, while most of the presidents of the other societies had passed the student age before the development of the modern engineering school.

Paul Martyn Lincoln, President of the American Institute of Electrical Engineers, was born in 1870 at Norwood, Mich. His father, a Congregational minister, soon moved to Illinois and later to Ohio. From the age of ten the boy lived on his grandfather's farm near Painesville, Ohio, where he attended school. He then spent one year in the classical course at Adelbert College before entering the Ohio State University, where he spent three years, graduating in 1892. A few months before graduation he took a position with the Short Electric Co., of Cleveland. During the latter part of the year he was sent by the company, as its engineer, to an electric-railway installation at Braddock, near Pittsburgh. The system was operated by a belt-driven dynamo similar in type to the well known Brush arc machine; the capacity was about 100 kilowatts; there were three or four cars using motors with Gramme ring armatures.

In a short time he joined the Westinghouse Company in Pittsburgh as a road-trouble man, his duties being to investigate difficulties with the operation of apparatus after its installation. A little later his work was in the testing room in connection with the development and testing of apparatus for the Niagara Falls Power Co. One incident was the operation of a rotary converter for deriving direct current from alternating current. This was something comparatively new, and the experts and advisers of the power company witnessed the test, which was a factor in determining whether direct current or alternating current should be adopted by the company. Alternating current was officially determined upon in 1893. The contract for generating apparatus was placed with the Westinghouse Company, and in March, 1895, Mr. Lincoln went to Niagara Falls with the first 5000-hp. generator and assisted in its erection. He became Electrical Superintendent of the power company, which began operation Aug. 26, 1895. Former alternators in this country did not exceed 1000 hp. in capacity; alternating current was used almost exclusively for lighting; the employment of electricity for power purposes on a large scale had scarcely been undertaken, so that the Niagara project in its initial installation of 15,000 hp. and its contemplated extension to 50,000 hp. or more was a tremendous forward step.

The problem of generating, of controlling by means of switches, circuit-breakers fuses, and the like, quantities of power far exceeding prior experience; the distribution of these large amounts of power and their employment locally in large quantity for various electro-chemical and allied industries which were springing up under the favoring conditions of cheap electric power; the project of transmitting power to Buffalo, 25 miles away, on a scale far exceeding anything that had been accomplished in transmission—all these things contributed to make the plant of the Niagara Falls Company a pioneer plant in which problems of a new order were encountered and which called for an intelligence and an initiative, a readiness to meet emergencies and to overcome difficulties which threw a great burden of responsibility upon the electrical superintendent of the plant. The success of this plant put electrical power generation and transmission upon a new footing. It established practices and standards; it was the starting point for new developments.

In this rare school of experience Mr. Lincoln laid the foundations for his engineering career in the generation and transmission of power. Shortly after the inauguration of the transmission service to Buffalo in 1901, he returned to the Westinghouse Company at Pittsburgh, where he has been connected with the Engineering Department and for a number of years has been the leading expert of the company in power transmission. In a sense, Mr. Lincoln has been a specialist; he may not be widely known to the general public. An independent consulting engineer may, through his identification with some particular work, be widely known, although his experience and contact with affairs may be far less than that of an engineer identified with a large manufacturing company. As a matter of fact, Mr. Lincoln in the engineering service of the company with which he has been associated has been called upon to advise in connection with practically every important transmission project of recent years. He is brought into consultation with the engineers connected with large plants and with consulting engineers, and there are few men who have enjoyed the breadth of acquaintance and the confidence of so large a number of engineers of the country who are identified with the largest electrical undertakings.

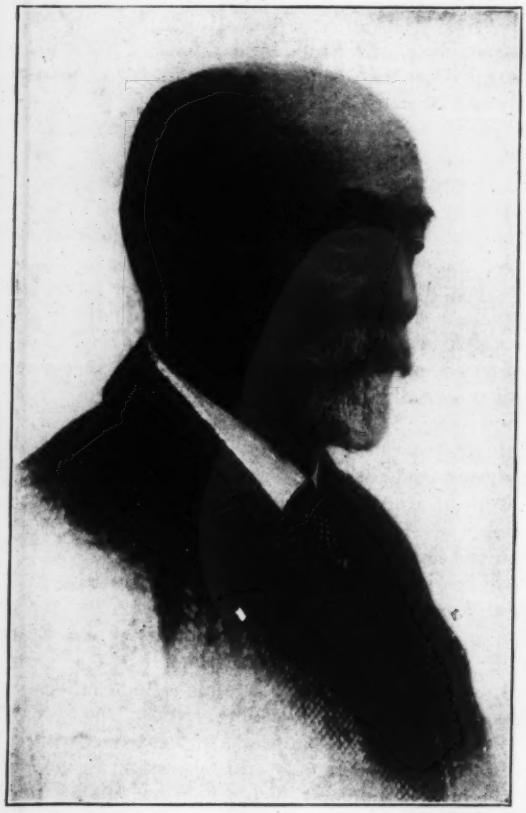
He has been active in the American Institute of Electrical Engineers, presenting numerous papers. He was a member of the Transmission Committee, which began its work a dozen years ago and which by papers, reports and discussions and published data with regard to transmission work has been a leading figure in the coöperation between designers, engineers of manufacturing companies and engineers of operating companies, and which has been a prominent factor in transmission developments. He has been for several years Chairman of the Committee on Local Organizations of the Institute. There are now over 30 sections located in different cities and over 50 branches formed by students in technical schools. In directing these activities and in visiting many of the organizations he has come in direct contact with the leading and progressive members of the Institute the country over. Few men have had more direct and sympathetic understanding of the status, the ideas and the plans of the Institute members at large than has its present president. He is Professor of Electrical Engineering in the University of Pittsburgh, directing its courses and delivering lectures and he is a member of the Publication Committee of the *Electric Journal*.

Mr. Lincoln is a positive, definite and original thinker. Those who have been intimately associated with him, as well as those whose acquaintance is slight or only through his writings, have regard and respect for his opinions and for the straightforward and frank way in which he is ready to express them.

Francis Clarke Gamble, President of the Canadian Society of Civil Engineers

By G. R. G. Conway*

For the first time since the founding of the Canadian Society of Civil Engineers in 1887 has the presidency been conferred upon an engineer primarily identified with the development of the great Pacific coast province. The Society in electing as President, F. C. Gamble, Chief Engineer of the British Columbia Department of Railways, has honored itself as well as conferred the highest honor at its command.



F. C. Gamble

Francis Clarke Gamble was born in Toronto in 1848. He comes of that sturdy United Empire loyalist stock, who remained faithful to the Royalist cause during the stirring events that led up to the American Revolution, events which compelled so many New England families to migrate to New Brunswick as early as the year 1774.

Mr. Gamble's father, Clarke Gamble, K. C., was born in 1807, and was a well known barrister of Toronto. When the Rebellion of 1837 broke out in Upper Canada, he served as an officer with the government forces. He was a greatly respected character in Toronto, and at the time of his death in 1901, at the age of 94, was the oldest barrister and volunteer in Canada. Mr. Gamble's mother, Harriet Eliza Boulton Gamble, was a daughter of the Honorable Henry John Boulton [illegible] folk, England, and of Holland House, Toronto, [illegible] time Chief Justice of Newfoundland, and later Attorney General of the Province of Upper Canada, as Ontario was then called.

Mr. Gamble received his education at Upper Canada College, Toronto. For a time this was supplemented by private tuition, prior to receiving a short course in engineering training at the Rensselaer Polytechnic Institute. During his student days he was a private in the Queen's Own Regiment, Toronto, and was one of the Canadian volunteers who routed the Fenians at Ridgeway after O'Neill's ill-fated expedition had crossed the Niagara River in 1866.

At the age of 21 young Gamble started upon his eventful career in railway engineering by graduating in the sternest of schools—as a chainman on the Intercolonial Ry. From 1871 to 1872 he was an Assistant Engineer on the Great Western Ry. between Niagara Falls and Windsor, Ontario; following this he spent two years on the construction of the Prince Edward Island Ry. as Resident Engineer for the contractor, returning again to the Intercolonial Ry. as an Assistant Engineer in 1876. A year later he entered the service of the Quebec, Montreal, Ottawa & Occidental Ry. as Assistant Engineer.

In 1879 he joined the Canadian Pacific Ry. as First Assistant Engineer on Contract No. 42, east of Winnipeg, and in 1880 saw his first service in the Province of British Columbia, when he was employed by the Dominion Government as First Assistant Engineer on the Yale-Savona section of the Canadian Pacific Ry. About the time Mr. Gamble was engaged in constructing railways in the province, his brother, Capt. J. H. Gamble, was serving in the Afghan war under Sir Samuel Browne, and was present at the taking of Ali Musjid.

In 1880 Mr. Gamble entered the service of the Dominion Department of Public Works in British Columbia under Sir J. W. Trutch, and in 1887 was promoted to be Resident Engineer of that Department; here he remained until 1897, when he resigned after 17 years' service.

The Government of British Columbia appointed him Public Works Engineer for the province in 1898, a position which he held until 1910. During this period, which was one of great activity in the expansion of the province, Mr. Gamble had the direction of many great undertakings, such as harbors, river control, diking, bridges and roads. In 1910, when the British Columbia Government was lending its aid to the great railway development of the province, which included about 2000 miles of new railway under provincial control, Mr. Gamble's long experience and sound judgment, as well as his great engineering skill, led him to be chosen to fill the position of Chief Engineer of the Department of Railways, a post demanding not only a high order of engineering ability, but a deep knowledge of men and affairs. His fine integrity of purpose has made him one upon whom the government and province place absolute reliance.

It is not possible in a limited space to do more than sketch the barest outlines of a busy life, but no engineer has ever brought to his calling a deeper devotion to its truest interests than the new President. The British

*Chief Engineer, British Columbia Electric Railway Co., Ltd.; Chairman, Vancouver Branch, Canadian Society of Civil Engineers.

Columbia members of the Society have looked to him as their wisest counselor, and in his endeavor to raise the status of the engineer in the province he has supported with energy every effort that has been made to advance the prosperity of the profession.

He believes that engineers should take a greater part in public affairs, and he has always fearlessly championed their cause. In Victoria, his home, he has gathered the engineers young and old around him, and as chairman during recent years of the local branch of the Society, he has been instrumental in raising the Society's status in the West to a position it has never before attained. At all times he has advocated a high plane of professional ethics, and his election to the President's chair is happily coincident with the movement for the introduction of a new code of ethics for the members.

In coöperation with the Vancouver branch of the Society, Mr. Gamble has been active in bringing the subject of the engineers' training and the qualifications of corporate membership in the Society before the Provincial Parliament, with the result that the local branches are assured at all times of the hearty sympathy of the government.

A large-hearted, generous man, diffident and modest, whose life both private and public is worthy of emulation, Mr. Gamble is deserving of every honor his professional brethren could bestow upon him.

Mr. Gamble has been a member of the Institution of Civil Engineers of Great Britain since 1891, and was elected a member of the American Society of Civil Engineers in the same year. He is also a member of the American Railway Engineering Association.

Mr. Gamble married in 1876 Sarah Eleanor, daughter of William Ewan Clark, a former member of the Legislature of Prince Edward Island. Mrs. Gamble died in 1887 leaving one son, Clark, who is following his father's footsteps, not only in adopting the same profession, but by offering his services as a loyal Canadian during the Boer war in 1899, where he took part in active campaigning until invalided home.

The Performance of the Electrically Propelled Collier "Jupiter"

The announcement of the plans to use electric propulsion (steam turbines, alternating-current generators and induction motors) on the new battleship "California" (see ENGINEERING NEWS, Dec. 10, 1914, p. 1190), on account of the success of the "Jupiter," has aroused interest in the performance of that collier. The following details of the operation and early trials are from a paper by Lieut. S. M. Robinson, U. S. N., before the Society of Naval Architects and Marine Engineers, Dec. 11, 1914.

The plans for this vessel were described in ENGINEERING NEWS, Sept. 12, 1912, and it is sufficient to recall here that the "Jupiter" is a twin-screw single-deck 14-knot vessel, of 19,300 tons displacement at 27 ft. 8½ in. draft. The overall length is 542 ft. 2½ in. and the extreme beam is 65 ft. 3 in. There are three double-ended Scotch boilers with forced draft, the incoming air passing through the motors and generators for preheating. The manganese-bronze propellers (designed by Capt. C. W. Dyson, U. S. N.) have a diameter of 15 ft. $11\frac{7}{8}$ in. and a pitch of 14 ft. $5\frac{1}{16}$ in. They give the vessel the same speed as sister ships on from 300 to 800 less horsepower.

The main propelling machinery consists of a nine-stage Curtis turbine (1990 r.p.m. normal), a two-pole three-phase generator, two 36-pole induction motors, two water-cooled rheostats and one main switchboard. The generator and motors serve solely as a reduction gear, and all speed changes are made by changing the turbine speed. There is but one normal cruising speed—the maximum. Resistance is used in the motor-rotor circuit in maneuvering, where much reversing might be expected, and on signal to back while at cruising speed.

EXTRACTS FROM TRIAL DATA: U. S. S. "JUPITER"

	2/14-14	2/18-14
Date		
Duration, hours	48	24
Speed, knots	14.99	10.01
Turbine steam pressure, lb. sq.in.	168.4	180.6
Vacuum, in.	28.2	28.5
Turbine, r.p.m.	2,130	1,410
Temp. main inj. water	55° F.	55° F.
Temp. feed water	191.9° F.	215.9° F.
Volts, generator	2,581	1,524
Amps., generator	1,480	808
Kw., starboard motor	2,692.7	712.5
Kw., port motor	2,833.1	751.3
Water consumption:		
Total, lb. per hr.	105,764	40,066
Turbine, lb. per hr.	83,552	24,820
Guar. turbine rate, lb. per hp.	13	15
Actual turbine rate, lb. per hp.	11.7	12.3
Coal consumption (New River and George's Creek):		
Total, lb. per hr.	11,900	5,050
Pounds per shaft hp.	1.7	2.5
Knots per ton coal	2.82	4.43

GENERAL PERFORMANCE

The "Jupiter" has been in commission over a year and a half. During that time she has conducted two official trials and has carried on the usual routine work of a navy collier. She has steamed about 14,000 miles and has been handled a great deal around docks, in narrow channels, and other places where a great deal of engine handling was required. About one-half of the steaming has been done in the tropics with circulating water over 80° F. and with correspondingly poor vacuum, so that the economy of the ship is known under all conditions. The fuel economy has proved to be excellent, being, on the average, about 25% better than the best of her sister colliers.

During the whole period of commission, two repairs have been made to the main engine. The first was to reblade the first stage of the turbine. This work was done entirely by the ship's mechanics. The accident was in no way peculiar to the electric drive, as it might very well have happened to any other engine. The other repair was to replace one of the porcelain cylinders which carry the resistances. This was done by two machinists in about two hours. The amount of work expended in keeping the equipment in condition has been very small. After a run, the turbine clearances are taken and the motor clearances are checked. (There has been no change in either.) Before getting under way the holding-down bolts, the slip rings, all insulators, all connections, and the oil switch boxes are examined, and the governor control-valve springs are tested. After starting the turbine, the emergency trip is tested. In port the oil pump is run once a week and the motor shafts are jacked daily.

In operation the "Jupiter's" drive has been highly satisfactory. There has been only one time that anything has happened during the handling of the motors, and that was the tripping out of an exciter. The lighting set was immediately put on for exciting, and the motors were ready to use again in about 1½ minutes.

The handiness of the drive has been proved more than once; the ship has been handled a great deal in narrow waters and around docks. She steers very badly at times and the quick response of the engines has more than once helped in getting out of difficulties. The ability of the turbine to stand severe abuse from water has been demonstrated several times. There is no separator on the main steam line, and several times the boilers have primed and carried considerable water over into the turbine. There was an increase in the first-stage pressure and a rattle in the casing as the water was hurled through at a high rate of speed, but the turbine blading showed no bad effects.

The backing qualities of the drive has proved to be all that could be desired; if the ship is cruising with the resistances in, the time taken for reversing is practically nothing at all; if the resistances are out, it takes a few seconds—not more than three.

Field and Office

Erecting a Building under a Tent in Winter

A notable piece of rush building construction work was carried out in Cleveland during the last month. In seventeen days a brick-wall building 90x202 ft. in plan, one story high with two monitors, was built for the Willard Storage Battery Co. by Gaylord W. Feaga Co., construction engineers.

The building is part of a new plant under construction in an outlying district. A rush of orders, topped off by a fire which destroyed part of the old plant downtown, made it necessary to hurry the work on the new plant to be in shape for work as soon as possible. Three buildings had already been completed at the new location, including the power plant (see its stack above the tent in Fig. 1). The building shown covered by a tent had to be rushed. Excavation for foundations was begun on Jan. 10. The contract called for the building to be ready for occupancy not later than Feb. 1 and required the contractor to guarantee the masonry work against the effects of freezing. On Jan. 27 the building was turned over to its owners.

The work was done under shelter of a tent 100x350 ft. with 10-ft. sidewalls. It is understood that the contractor paid $1000 for the use of the tent for 30 days, the tent company putting the tent up, raising it several feet after the first stage of the work, and removing it, besides carrying the risk of damage. When the lower 10-ft. height of the brickwork was being laid, the tent was in its first position, its sides reaching to the ground. Then it was raised to allow carrying up the rest of the height of the building.

A workshop was provided for carpenters and other mechanics under part of the tent (the part not raised, at the left of Fig. 1). The space under the tent was heated by steam brought from the power plant. Heating pipes were placed along the inside of the walls of the building and through its center. Fig. 2 shows the heating pipes along the center line of the building.

During part of the time of construction the weather ranged between 0 and 10° F. When the view (Fig. 1) was taken there was much unmelted snow on the roof of the tent, although the sun was shining and steam was on in the building.

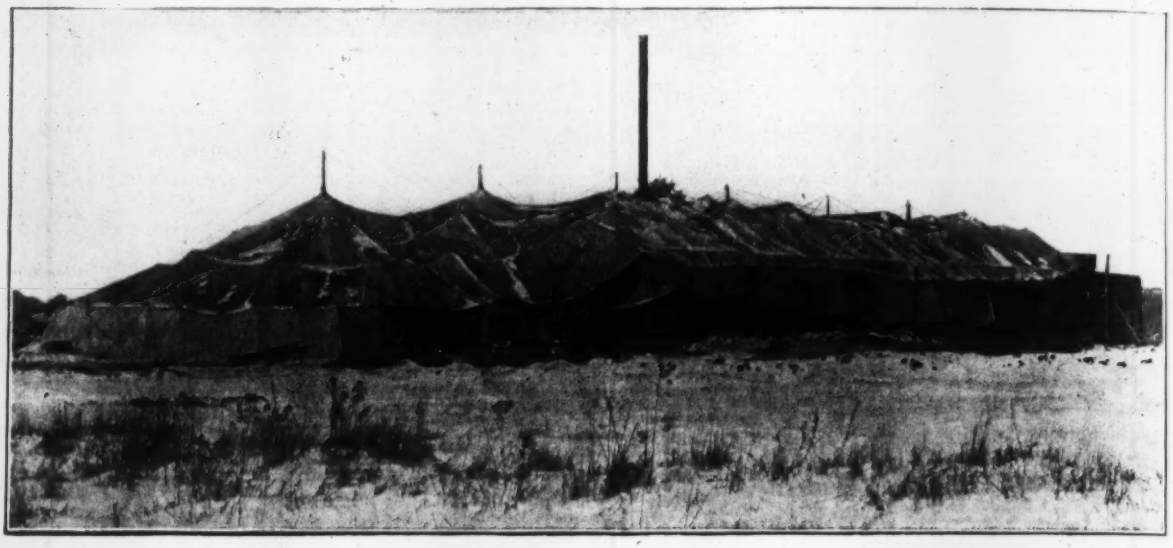


FIG. 1. BUILDING A SHOP UNDER A TENT

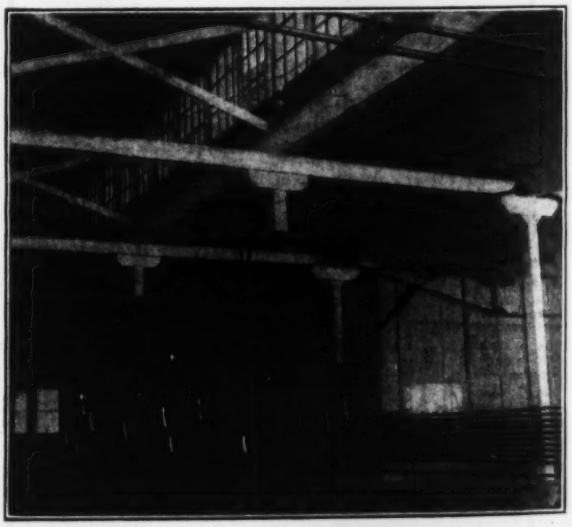


FIG. 2. HEATING-PIPES IN THE SHOP UNDER THE TENT

Fifteen Years' Wage Increases in the Canadian Northwest

The accompanying table, from the recent report of the city engineer of Winnipeg, gives an interesting and valuable summary of the wage increase among workers in construction industries—except the professional engineer, whose wage or salary has doubtless remained stationary.

CITY OF WINNIPEG—FAIR-WAGE SCHEDULE, 1890 TO 1914

[In Cents per Hour. In Last Seven Columns the Hours per Day Are Given in Parentheses]

Trade or Class of Labor	July 23, 1890	July 22, 1891	July 27, 1892	July 19, 1893	July 18, 1894	July 17, 1895	July 28, 1896	July 26, 1897	July 23, 1898	July 22, 1899	July 20, 1900	July 20, 1901	July 19, 1902	July 18, 1903	July 15, 1904	July 28, 1905	July 27, 1906	July 26, 1907	Nov. 12, 1908	Nov., 1909	Aug. 23, 1910	Nov. 1, 1911	Jan. 11, 1912	June 7, 1913	Mar. 4, 1914
Builders' laborers																			25 (10)	25 (10)	27 (10)	27½ (10)	27½ (10)	27½ (10)	27½ (10)
Ordinary laborers	14	14	14	14	14	14	14	14	16½	17½	17½	17½	17½	17½	17½	17½	20	20	20 (10)	20 (10)	25 (10)	25 (10)	25 (10)	25 (10)	25 (10)
Excavators																			20 (10)	20 (10)	25 (10)	25 (10)	25 (10)	25 (10)	25 (10)
Team and wagon	39	33½	33½	33½	33½	33½	33½	33½	33½	40	40	44	45	45		50	50	50	50 (10)	50 (10)	60 (10)	60 (10)	60 (10)	60 (10)	60 (10)
Team driver																20	20			20 (10)	25 (10)	25 (10)	25 (10)	25 (10)	25 (10)
Single horse																	30		35 (10)	35 (10)	35 (10)	35 (10)	35 (10)	35 (10)	35 (10)
Carpenters—																									
Ordinary	20	20	20	20	20	20	20	20	20	25	25	25	25	25	25		25	25	35 (9)	35 (9)	45 (9)	45 (9)	45 (9)	55 (9)	45 (9)
Finish																									50 (9)
Form																									35 (9)
Lathers																			40 (9)	40 (9)	40 (9)	50 (9)	45 (9)	56½ (9)	56½ (9)
Plasterers																			50 (9)	50 (9)	55 (9)	60 (9)	60 (9)	65 (8)	65 (8)
Painters and decorators						16½		25							27½				30 (9)	30 (9)	40 (9)	40 (9)	40 (9)	42½ (9)	42½ (9)
Plumbers																			50 (9)	50 (9)	50 (9)	50 (8)	50 (8)	55 (8)	55 (9)
Bricklayers				45		50		50		50	50	50	50	52½	55	55			60 (9)	60 (9)	62½ (9)	67½ (8)	70 (8)	70 (8)	70 (8)
Masons																		55	60 (9)	60 (9)	62 (9)	67½ (8)	70 (8)	70 (8)	70 (8)
Stonecutters										45		50							60 (8)	60 (9)	60 (8)	60 (8)	60 (8)	65 (8)	65 (8)
Marble-workers																							45 (9)	65 (9)	55 (8)
Tile-setters																								55 (9)	55 (8)
Asbestos-workers																								50 (9)	50 (9)
Hoist engineers																			40 (10)	40 (10)	40 (10)	40 (10)	50 (10)	50 (10)	50 (10)
Derrick engineers																									60 (10)
Electricians																			35 (9)	35 (9)	40 (8)	40 (8)	40 (8)	45 (8)	45 (8)
Sheet metal workers	35																		39 (9)	39 (9)	42 (9)	42½ (9)	42½ (9)	45 (9)	45 (9)
Steamfitters																			50 (9)	50 (9)	50 (9)	50 (8)	50 (8)	55 (8)	55 (8)
Bridge and structural iron wks																			40 (9)	40 (9)	40 (9)	50 (9)	50 (9)	50½ (9)	50½ (9)
Blacksmiths							16½	20	20	20	22½	27½	27½	27½	27½	27½	27½		27½ (10)	27½ (10)	42 (10)	42 (10)	42 (10)	42 (10)	42 (10)
Molders																			32½ (10)	32½ (10)	32 (10)	32½ (10)	32½ (10)	32½ (10)	32½ (10)
Boilermakers															30	30	35	27½		41½ (9)	40 (10)	40 (10)	40 (10)	40 (10)	40 (10)
Machinists															25			25		40½ (9)	42½ (9)	42½ (9)	42½ (9)	42½ (9)	42½ (9)

Hoist for Reinforcing-Steel

By H. DaCamara*

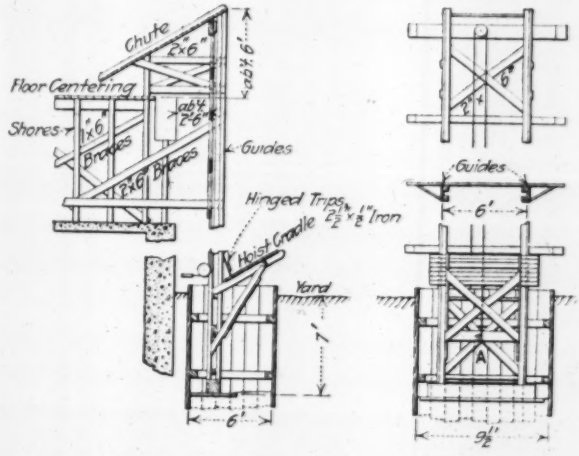
In the construction of the new Ford automobile assembling plant in Cincinnati, Ohio, the problem of getting the reinforcing steel up to the different floors was solved very satisfactorily by the use of a special hoist.

A pit 6x9½ ft., 7 ft. deep, was dug at the side of the building most convenient to the steel yard. This pit was sheeted up with 2-in. plank, suitably braced in place, as shown in the sketch. Hoist guides, built of 4x4's fastened with ½-in. bolts to a 2x12 plank, were set in the pit at a spacing of 6 ft. inside to inside of the 2x12's, and braced with 2x6's to form a rigid section. They were erected from the bottom of the pit up to about 6 ft. above the level of the floor to be constructed, and were kept 2 ft. 6 in. away from the finished wall line in order not to interfere with the wrecking of the beam panels or the bricklaying. Braces run from the shores under the floor to the guides made it unnecessary to use guy wires. At the top a chute was built down to the floor on a slope of 4 on 6.

A hoist cradle having the same slope as the chute was constructed on 4x4-in. runners and braced with 2x6's. The important part of this cradle consisted of two triggers or trips 2 ft. long made of 2¼x½-in. iron, hinged to the frames so as to slide up the front face of the guides.

A single hoist line was used, being fastened to the crosspiece of the cradle at *A*, low enough to give clearance at the top sheave. The top sheave, 10 in. in diameter, was placed 5 in. off center to prevent binding at the end of the lift.

The load was placed in the cradle (the triggers keeping it from wedging against the guides) at the yard level and on a signal to the engineer was hoisted to the top, where the triggers swung over the rounded ends of the guides, automatically dumping the contents down the chute onto a platform on the floor.



HOIST FOR REINFORCING-STEEL, USED IN BUILDING FORD ASSEMBLING PLANT, CINCINNATI, OHIO

The possibilities of this contrivance are almost unlimited, since by means of it the inconveniences of the tag line and the sling are eliminated. This applies especially to the loading and hoisting of reinforcing steel, decking, shores, braces and other building materials.

*3231 Bishop St., Cincinnati, Ohio.

Horizontal Cross-Hair Adjustment of the Engineer's Transit

By M. F. Sayre*

It is believed that the level and transit adjustment to "make the horizontal cross-hair pass through the optical center of the instrument" is not generally understood nor adequately treated in textbooks. The conditions are shown, much exaggerated, in the accompanying sketch. The following is an analysis of this adjustment:

On the near rod A is the point sighted. The axis of the telescope is OF_1C_1, which is assumed to pass through the horizontal axis of the instrument O. The ray OA, the apparent axis of the telescope, intersects the far rod at B. If the cross-hair and telescope axis are in adjustment, OB and OC_1 coincide.

Assume that the cross-hair W_1 is e distant from the telescope axis. Focus on the near rod. The ray from A through F_1 the principal focus, will meet the objective at H_1, so that W_1H_1 will be parallel to OC_1. The ray

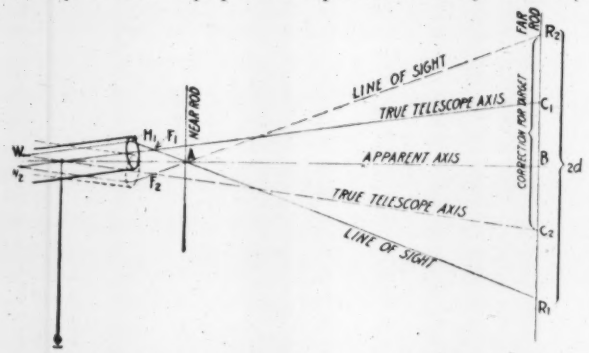


Diagram Illustrating Horizontal Cross-Hair Adjustment of the Engineer's Transit

$W_1H_1F_1$ prolonged meets the far rod at R_1 (neglecting a slight shifting due to refocusing).

Invert the telescope and resight on A; the cross-hair is now on the under side of the telescope axis, and the diagram is reversed, the ray from the cross-hair striking the far rod at R_2. The point B is midway between the two sights, in line with OA (about which the telescope has been rotated), but the telescope axis does not lie along OAB, but along OF_2C_2. The target must be moved not to B but to C_1, and the cross-hair then adjusted to strike it.

By comparing the sides of similar triangles and combining, the following formula may be developed:

$$R_2C_2 = d + d\frac{S_1 - (f+c)}{f+c}\frac{S_2}{S_2 - S_1}$$

or approximately:

$$R_2C_2 = d\frac{S_1}{f+c}$$

where d is one-half the apparent discrepancy on the far rod.

Supposing $f + c = 1.4$ ft., and S_1 the distance to the near rod = 10 ft.; the target on the far rod must be moved past the midpoint B and seven times as far as half the discrepancy. Thus, if the first reading was 5.10 and the second 5.02, the target must be moved to 5.30, and the cross-hair adjusted to it. The standard textbook instructions would have the target set at 5.06. The full instructions should read as follows:

Set up the transit at some point where you can get a clear level sight 300 ft. long. Clamp the telescope in an approximately level position, bubble erect. Establish a point on a near rod, held about 10 ft. from the instrument; then without shifting the telescope except to refocus, set a target on a far rod, held on a stake 300 ft. distant. Invert telescope, turn in azimuth, sight on the same point on the near rod, and check on the far rod. Divide the distance, transit to near rod, by the value of $f + c$ for your instrument, and multiply this ratio by half the difference between the two readings on the far rod. Move the target by the amount of this correction, and shift the cross-hair to agree. The movement is upward if the second reading was the smaller of the two; downward if the larger.

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The Computing Machine for Areas of Irregular Tracts

By C. D. Norton*

The writer has used a calculating machine for finding the areas of large irregular cross-sections. A simple example is shown below by sketch and table computations.

The headings of Cols. a, b and c are self-explanatory.

Col. d is the algebraic difference between Cols. b and c.

Col. e is the product of Cols. a and d.

Col. f is the algebraic sum of Col. e as shown on the result counter of the machine.

It will be noticed that although the same figures are used in each of the two calculations, the products are entirely dissimilar, insuring a mathematical check on the accuracy of the work.

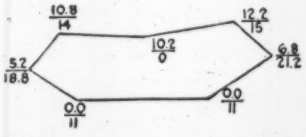
FIRST COMPUTATION OF AREA

Numerators	Alternate Denominators				
a	b	c	d	e	f
10.2	—15.0	14.0	—29.0	—295.8	—295.8
12.2	—21.2	0.0	—21.2	—258.64	—554.44
6.8	—11.0	—15.0	4.0	27.2	—527.24
0.0	11.0	—21.2	.....	.....	.....
0.0	18.8	—11.0	.....	.....	.....
5.2	14.0	11.0	3.0	15.6	—511.64
10.8	0.0	18.8	—18.8	—203.04	—714.68
Sum of products....				—714.68	
Area = ½ sum.....				357.34	

CHECK COMPUTATION

Denominators	Alternate Numerators				
a	b	c	d	e	f
0.0	12.2	16.8	1.4	.....	.....
—15.0	6.8	10.2	—3.4	51.0	51.0
—21.2	0.0	12.2	—12.2	258.64	309.64
—11.0	0.0	6.8	—6.8	74.8	384.44
11.0	5.2	0.	5.2	57.2	441.64
18.8	10.8	0.0	10.8	203.04	644.68
14.0	10.2	5.2	5.0	70.0	714.68
Sum of products.....				714.68	
Area = ½ sum of products.....				357.34	

It does not matter whether the resulting sign be plus or minus, but the greater must be found by inspection, and used as plus on the machine, or a complement will be the result.



In P. H. Skinner's article "Computing Machines in Engineering," Jan. 7, 1915, p. 26, in the paragraph describing the working out of $\frac{17}{32}$ multiplied by 36, the positions of the two figures 52 and 17 should be reversed on the machine, the 52 being set on the extreme left of the multiplicand, and this number is built up until 17 is

*Sudbury, Ont.

obtained underneath it. And under the heading "Square Root, Second Method" on the same page, in the third line of the paragraph it should read: "unity is subtracted from the *left-hand* period."

A Unique Method of Sinking Shafts in Soft Ground

By Lloyd T. Emory*

In the mining of kaolin in the Central and Southern states a simple method has been developed for timbering the shafts or pits from which the material is taken. To meet local conditions it was necessary to devise a plan by which the timber could be used repeatedly, and one which would also leave the pit free from braces, so that the hoisting of skips with a derrick would not be interfered with.

The following description covers the method as used on the property of the Kaolin Mining Co., near McIntyre, Ga. In other localities, notably Hockessin, Del., Penland and Dillsboro, N. C., the diameter of the shaft and size of the timbers vary slightly to meet local conditions or the individual ideas of the operators.

The shafts are from 20 to 25 ft. in diameter and their average depth is about 60 ft., although they are frequently sunk to a depth of over 100 ft., even through soft and sometimes treacherous material.

The pit is first dug about 4 ft. deep, keeping the hole round by means of a piece of plank swung around a peg in the center, as a gage. The pit is then lined with 3x8-in. planks cut in 3-ft. lengths with mitered ends, laid *flat;* fitted together a layer of these planks forms a complete ring around the pit. The first ring of timber is laid around the bottom of the pit, a second placed on top of it, breaking joint; these two are spiked together. Then the rest of the curbing to the top of the excavation is laid up, always breaking joint. Sections of 6 or 8 rings are placed at a time. Every fourth or sixth set of timbers is spiked to the ring below with 40d. nails, to prevent slipping.

It can readily be seen that this curbing will act as an arch, like the wall of a pipe under external pressure. Therefore considerable care is necessary to see that any vacant space behind the timbering is thoroughly tamped with dirt, as soft spots behind the wall will allow the timbering to be deflected from a circle, which will throw unequal stresses on different portions and may result in failure.

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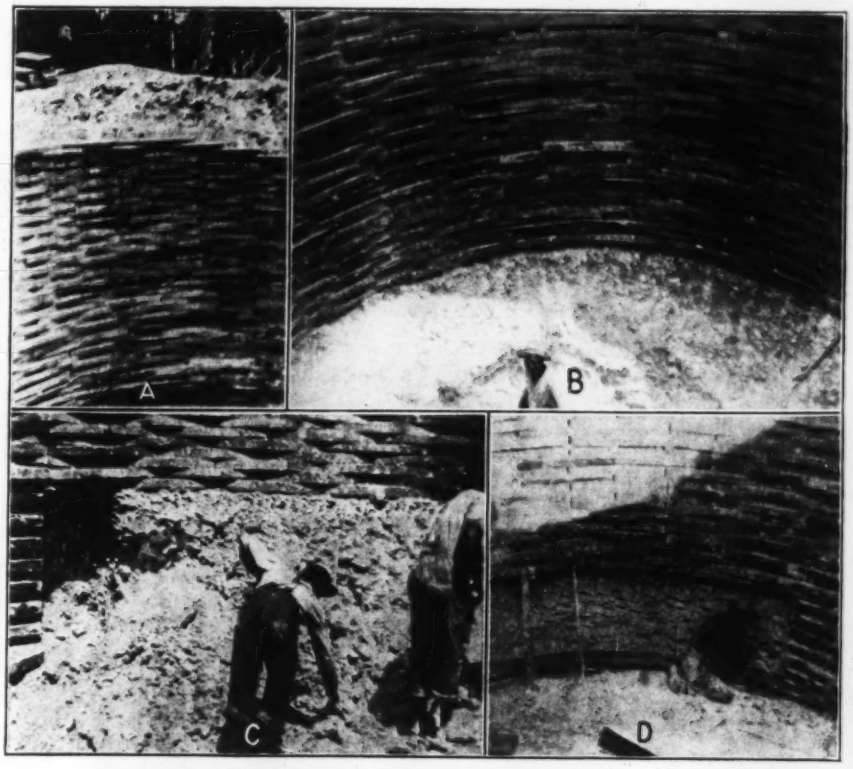
After thus curbing the shallow pit first dug, the work is continued by excavating another 4-ft. depth, but using a smaller radius, leaving the timbering already in place resting on a ledge. If the material is firm, this ledge may be cut down almost straight with the inside edge of the timber. In case of very soft saturated material it may be necessary to leave a toe 6 to 10 in. wide and thence slope the material toward the center of the pit. In working in wet ground a small sump may be dug on one side of the pit and the floor kept so sloped that all the water can be either bailed or pumped from this depression.

When the pit has been excavated at the smaller radius to about 4 ft. below the bottom of the timbering, narrow vertical trenches are cut into the sides under the timber at frequent intervals around about a third of the circumference of the shaft, and temporary wooden struts placed to support the bottom ring of timbering. The earth between the struts can then be excavated to the full radius and another section of timbering started. The second ring is always spiked to the bottom one and every fourth or sixth spiked as above described. The ends of this timbering where it will join the adjacent segments can be either "stepped down" or "saw-toothed." It is well to use the first method on one end and the latter on the other. As soon as this timbering is in place the performance is repeated with another segment and so on until a complete section is in place.

Sometimes difficulty is experienced in putting in the last piece of timber of a section. If the ring can not be sprung enough to get it in, a short piece of timber is



A. Upper Part of a Deep Shaft. B. Excavating in the Center Before Starting a New Section. C. New Section of Lining Started. D. Preparing to Close a Set of Rings

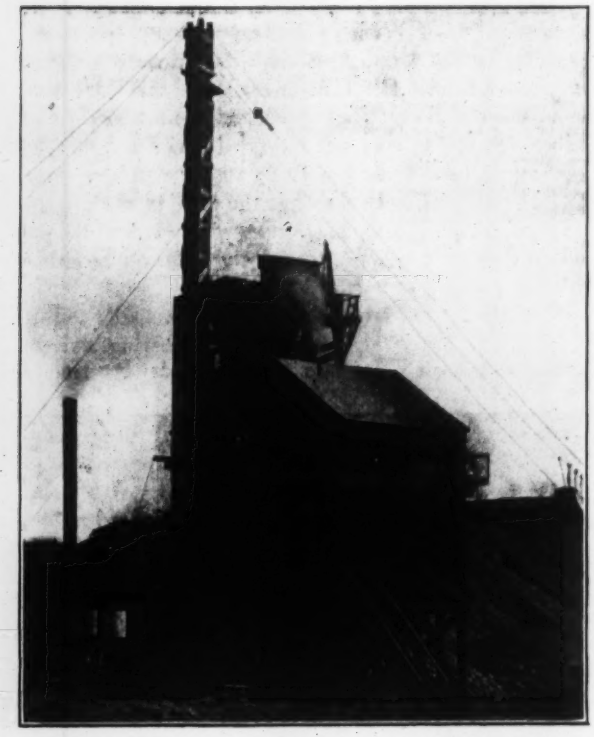


FIG. 1. SAND AND GRAVEL PLANT WITH DRAGLINE EXCAVATOR OPERATED FROM A BUILT-UP TIMBER MAST 84 FT. HIGH

used so as to allow a 3x3x8-in. key to be inserted which is toe-nailed to the adjoining timbers.

The number of rings which can be put in at a time depends upon the character of the soil and is best determined by experience. Where a trustworthy man is employed as foreman it is best to leave the number to his discretion. It is not advisable to place less than four rings, and eight rings are about the maximum that can be placed at one time.

To remove the timbering the shaft is backfilled with waste from other workings. The work is done in a similar way to the excavating, but in the reverse order. In most cases the pressure of the earth against the sides will make each section practically self-supporting, but as a precaution props extending toward the center of the shaft are placed so as to support the lining 4 or 5 ft. above the bottom. The lower section of timber is then removed from below the props and the shaft backfilled up to the bottom of the timbering. It is customary to excavate a new shaft as the old one is being filled; in this way the timbering can be handled by one derrick for both holes, and the overburden and trimmings from the new excavation dumped into the old one.

COST OF EXCAVATION

The average cost of excavating under this method for five shafts was 54c. per cu.yd., exclusive of the cost of the timbering, which was used repeatedly. The material excavated had to be loosened with picks before shoveling, and owing to seepage and rainfall considerable bailing was necessary. The first 10 or 15 ft. penetrated was sand and yellow clay. The remaining depth was alternate seams of sand and almost pure kaolin of a sedimentary origin. Water was encountered in the upper sand seams.

On the property of the Harris Clay Co. at [illegible], N. C., where the deposits are of residual kaolin [illegible] in decomposed pegmatite dikes, the shafts are made [illegible] 15 to 20 ft. in diameter and the timbers are cut [illegible]30 in. and are laid on the 6-in. side.

The method might be used on engineering work [illegible] foundations where too much water is not encountered [illegible], the material penetrated is stiff clay and small boulders which make the driving of sheetpiles difficult.

Large Built-Up Timber Mast for an Excavator

The built-up timber mast shown in the accompanying cuts is part of a dragline excavator outfit at a sand and gravel plant built by the Raymond W. Dull Co., of Chicago. The mast, bucket and plant are shown in Fig. 1.

The general design and details of construction of the mast are shown in Fig. 2. The mast is 3 ft. square, built up of four 8x8-in. posts with 2x12-in. struts and diagonals. The top is of special construction, as shown, for the attachment of the blocks and guy lines. The bottom sections of the posts are 18, 21, 24 and 30 ft. long, so that all the splices are staggered.

In many cases the masts for dragline excavator work are single timbers reinforced by steel truss-rods and struts, but where the work requires masts 75 to 90 ft. high it is not easy to get timbers of the required size and strength. The built-up mast is composed of timbers readily obtainable, and it requires no trussing.

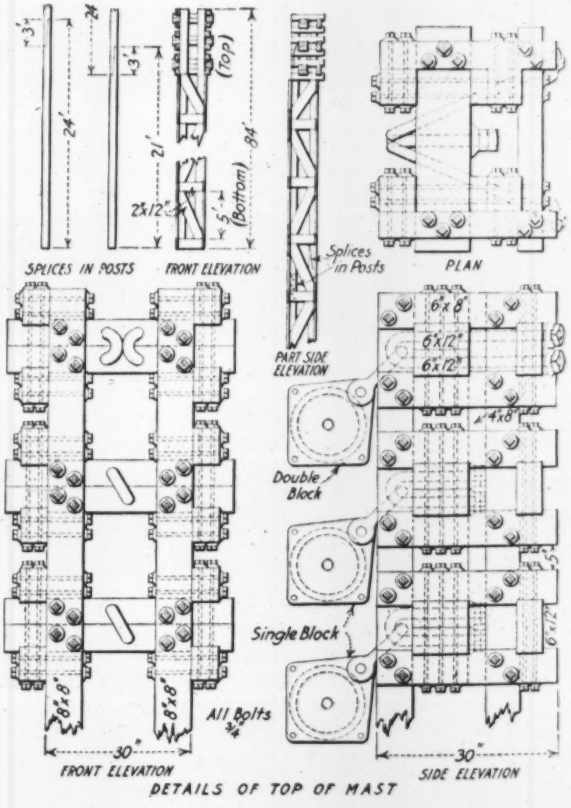
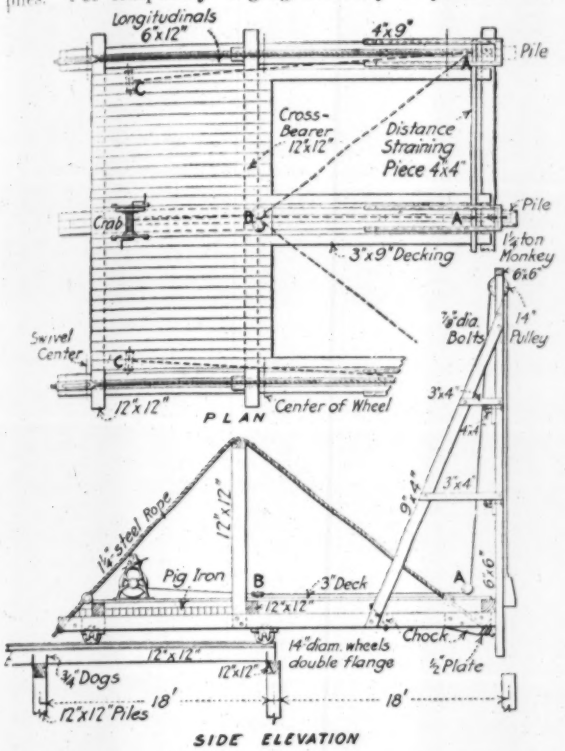


FIG. 2. CONSTRUCTION OF 84-FT. TIMBER MAST

Overhang Piledriver

By Leonard Goodday*

In driving piles for a wharf, jetty or pier, a great deal of time is lost getting the true position and pitching the piles. For temporary staging accuracy of position does not so much matter, but for permanent work it is most essential.



Overhang Triple Piledriver for Trestle and Wharf Work

Some 16 years ago, the writer when constructing a wharf about 600 ft. long (in one of the British dockyards) and having 18-ft. bays with three piles to each bent at 12-ft. centers, erected an overhang traveling platform carrying three piledrivers, spaced 12 ft. apart, by which means the spans could be fixed quickly, and three piles driven either simultaneously or singly. This machine worked accurately, without any trouble, and gave every satisfaction.

For a jetty or pier the traveler can start straight from the bank; for a wharf, as in this case, it is necessary to run out square with the bank, construct sufficient staging to slew round, and run then in any direction required.

The weight of the plant complete was 12 tons, to which was added sufficient pig iron to balance it on the front wheels plus about two tons as a factor of safety against tipping, which would consist for driving three piles simultaneously of two extra winches and pig iron at the rear, or for single driving of pig iron alone. The traveler can also be lashed down at the rear.

The machine is run out to the required distance and fixed, the three piles driven and cut to the level required; the cross-beams are then placed and dogged, the longitudinal beams laid directly over the center of the piles driven, and dogged to the cross-beams. After another 18-ft. length of rails is laid, the traveler is moved on for another bay. When two sets of piles are driven, the construction of the walings, bracing and decking is then commenced, and follows up the piling. The crab is placed as shown on the plan, the monkeys being worked one after another; but if simultaneously worked, two extra crabs are placed as shown at C and C'. The hauling rope is guided by a snatchblock at the foot of each machine and passes between the fair-leads. When worked singly, one rope only is required for this as it is coupled to each one on the machine in rotation by a coupling between the crab and snatchblock; when worked simultaneously, there is naturally a separate rope to each. The dotted lines on the plan show their lines of direction. The snatchblocks are most convenient, as the ropes can be thrown out of gear without waste of time, as when reefing.

*Civil and Mechanical Engineer, late of the British Admiralty, 552 O'Connor, Ottawa, Ont., Canada.

Supplementing the Canadian Public Land Surveys by Rapid Stadia Work

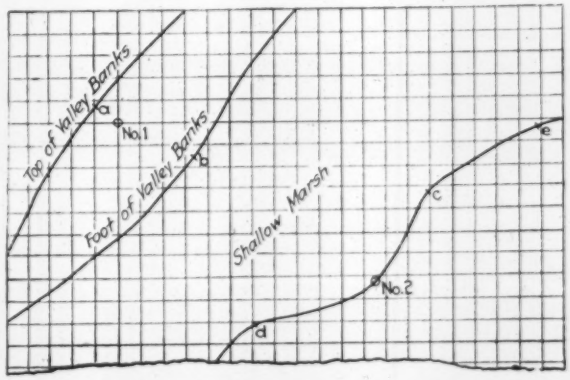
By J. A. Macdonald*

The Canadian Government through its Topographical Surveys Branch of the Department of the Interior, under Dr. E. Deville, has for some time past been engaged in supplementing and revising its public-land plats, so as to show all rivers, lakes and other bodies of water. The

*Topographical Surveys Branch, Department of the Interior, Ottawa, Ont.

LAKE No. 2 TP. 108 R6. 14 W. 5TH MER.
DATE May 14 1914

POINT	UNCORR'D. DISTANCE	BEARING	VERTICAL ANGLE	CORRECTED DISTANCE	REMARKS
	Station 1 at N.E. Corner				Sec. 13
	Set Instrument by Compass				
	Azimuth of Magnetic North				34° 25'
	Index Correction				+ 12'
	Convergence				- 3'
	Set Instrument to Compass North				34° 34'
a	1.50	307°00'	6°40'	1.52	Top of Valley Bank
b	3.50	115°30'	82°45'	3.53	Foot of Valley Bank



Sample of Field Notes; Stadia Survey, Canada Topographical Surveys

work is of interest because of its extent and its cheapness, and because stadia methods were used exclusively.

BASIS OF SURVEYS—Like the middle and western parts of the United States, the greater part of Canada is divided by the same system into rectangular townships 6 mi. square, subdivided into sections 1 mi. square. This furnishes the network for the stadia surveys.

FIELDWORK—The survey parties each consist of a surveyor, one assistant, two rodmen and a cook. For transportation two teams and a folding boat are provided.

A township or section corner adjacent to the body of water is selected as the initial point for each survey, and a line is run to the shore of the lake or river. Where possible the stadia shots around the lake are taken from a single station. Soundings are taken by the rodmen, using their rods or hemp sounding line.

All horizontal angles to stadia shots are referred to the true meridian, as established by setting off the declination and other corrections from the magnetic meridian, at the initial point of each survey. A check on the traverse angles and distances is had by tying into the next adjacent section corner. Where no boundary ties are possible, an astronomical observation is made to determine the true meridian. The illustration (see preceding page) shows a part of a page of field notes.

In addition to surveying all streams and bodies of water the following additional notes are taken: The estimated horizontal distance between high and low water marks; the nature of the shore, sandy, marshy, etc.; the nature of the banks, high, low, rocky, dry, timbered, etc.; the nature and extent of the slopes, and the approximate depth of water, wherever it can be obtained—in short as many topographical features as possible without expending too much time. Other points to be noted are whether any section lines require to be surveyed, where bodies of water have dried up; what condition the section corner monuments are in; and data for revising on the plat the location of roads, trails, creeks, etc.

PLATTING—The original plats are made in the field on sheets of ruled or cross-section paper, usually on a scale of 10 chains to the inch. Inclined sights are reduced by slide-rule, and the instrumental constant is neglected except in the station traverse. Each sheet contains a description of the lakes, the numbers of the townships, range and meridian, the surveyor's name, the date and the number of the fieldbook containing the notes.

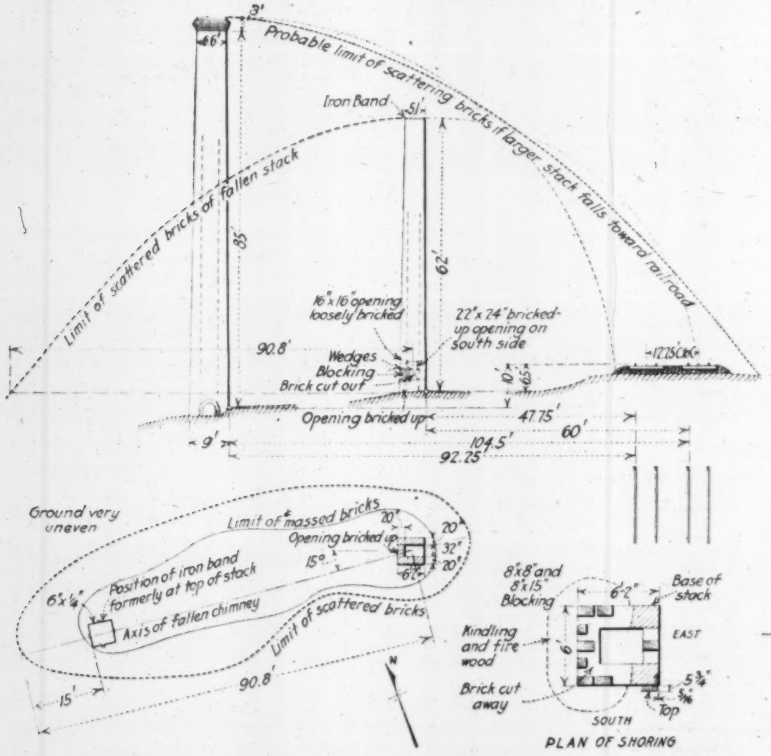


FIG. 1. SKETCH OF STACK, METHOD OF BLOCKING, AND AREA OF FALL

Felling a Brick Chimney

BY CHARLES A. MEAD*

On Jan. 23, 1915, an old brick chimney near Camden, N. J., was taken down because its condition was getting so poor that it was becoming a menace to safe travel on an important railway nearby. Two brick chimneys stood on this tract, forming part of an old brick manufactory, the buildings of which were dismantled more than a decade ago. The larger stack is still standing because it is at the present time in sufficiently good and plumb condition to cause no apprehension for its stability.

The smaller stack measured 6 ft. 2 in. by 6 ft. at the base, and stood 62 ft. high above the ground. It was out of plumb, the top (by computation) overhanging the base 5¾ in. to the southward. At the base the walls were 20 in. thick. No other dimensions were available and no plans existed for the stack. The lime mortar had weathered out of the joints to a depth of 1 to 1½ in., and the brickwork on the outside was disintegrating. Due to a number of openings in the base of the stack, some of them roughly bricked up (see detail in photographs in Fig. 2), a very weak horizontal section was formed above the ground, which it was feared would be inadequate to resist heavy winds—a velocity of 75 mi. per hr. has been recorded in this vicinity.

Fig. 1 shows the direction in which the smaller stack fell and the approximate areas covered by the massed brickwork and the scattered bricks. The ground on which the stack fell was very rough, which accounts in part for the irregular outline of the diagram, which was plotted after establishing the center line shown and measuring offsets at intervals of 10 ft. The maximum width covered was 36 ft.

The stack fell as a monolith, but after the fall it covered a distance along the ground 50% greater than its height.† It was observed that while the stack was going through the first third of its fall, it remained practically intact (Fig. 3). At that point the base seemed

*Chief Inspector, Division of Bridges and Grade-Crossings, Board of Public Utility Commissioners of New Jersey, Newark, N. J.

†If the larger stack should fall toward the railway and obey the same law as the smaller stack did in falling, it would cross the tracks and the flying bricks would extend 19 ft. beyond the farthest rail.

to shear off, and transverse cracks appeared at the same instant all the way along the shaft; these cracks rapidly widened as the stack fell. Very few bricks adhered to each other after the fall beacuse they were laid in lime mortar which had little adhesion; the brick was of medium grade and not very hard.

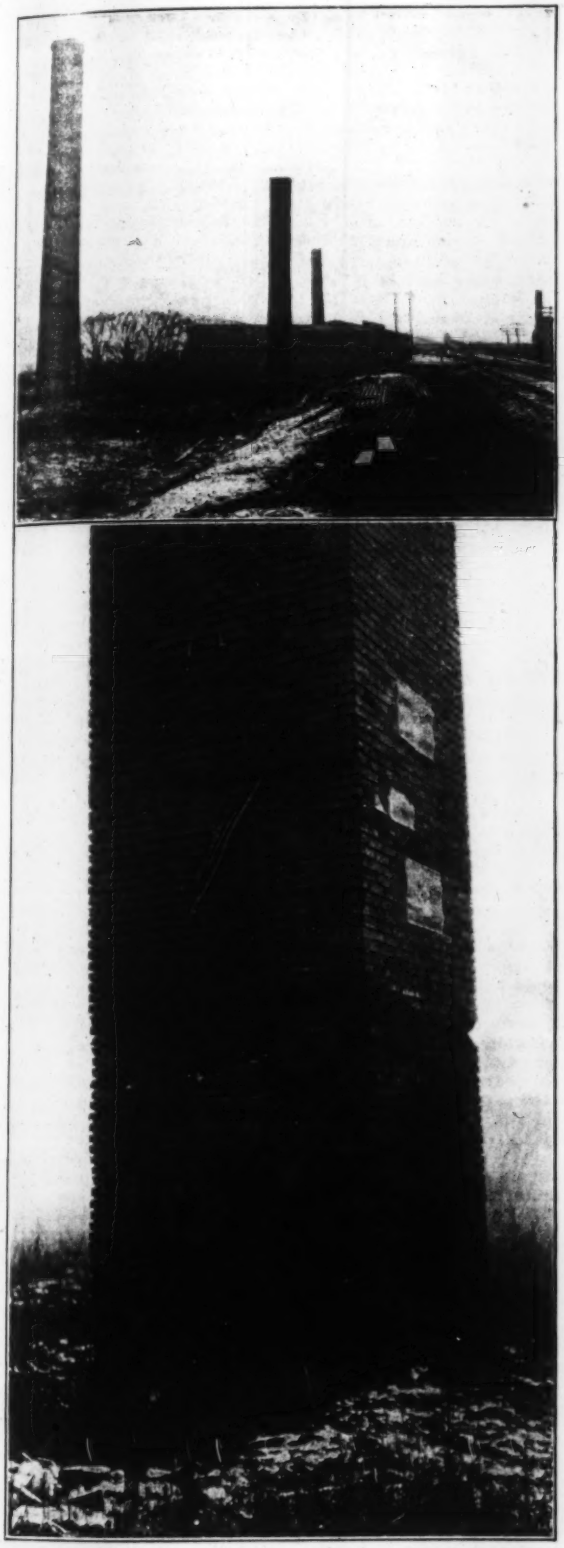


FIG. 2. THE TWO OLD STACKS, AND NEAR VIEW OF BASE OF SMALL STACK

HOW THE STACK WAS FELLED

Each of the two corners on the west face was cut out sufficiently to insert a piece of 8x15-in. yellow-pine timber, which was wedged in tightly to the brickwork, forming a temporary support at these places. The brickwork of the west face was then removed between these timbers and three similar blocks of yellow pine inserted in the holes and wedged up tight. Then on the north and south faces immediately back of the first posts similar posts were inserted. After these had been wedged up, the brickwork was cut away for a little distance past the center of the stack, leaving two piers of brickwork about 20 in. square, one at the northeast and one at the southeast corner. In order to strengthen the old opening where the breeching entered, a post was inserted and wedged in tightly.

Kindling was applied all around the timber blocking on the west face and firewood piled against the blocking on the outside. The mass was then saturated with kerosene oil and fire started at 11:24 a.m. At 12:36 p.m. the blocking was sufficiently burned away to allow the stack to fall.

FIG. 3. FALL OF THE STACK

The temperature at the time was 40° F., the wind was from the southwest and the weather was rainy. Owing to these conditions the blocking at the southwest corner burned less rapidly than the rest, so that as the stack began to fall this corner momentarily carried most of the weight, causing the stack to heel slightly and swing to the south. The line of fall was 15° off the east-west axis of the stack.

The work of felling the stack was done by the railway forces after the owner's permission was obtained.

NOTES

Concrete Curb constructed as an integral part of the pavement is being used in some places, and is said to effect a saving in cost, while it avoids any longitudinal joint between curb, gutter and paving. It is essential that the transverse joints in the pavement should extend through the curb. In one case where the asphaltic felt used as a joint filler did not always extend to the rear face of the curb, the face of the curb cracked from expansion and was broken off for a distance of 4 to 6 in. on each side of the expansion joint. The

low curb adapted for boulevard and parkway traffic can be constructed by using a strikeboard with ends conforming to the gutter curvature, no form being required for the inner face of the curb. For heavier traffic, a higher curb should be used. With this, the pavement is first struck off in the usual manner, then a board is clamped to the outer form to act as the form of the face of the curb, spacers holding it at the required distance and position. If reinforcement is used in the pavement, it should be bent upward into the curb space.

Crane Attachment for Turning Objects Over—A device for turning over flasks in foundries is shown in the accompanying view, taken in the foundry of the National Transit Co., Oil City, Penn. A beam notched on its upper surface is suspended horizontally from a crane hook. At each end of the beam an

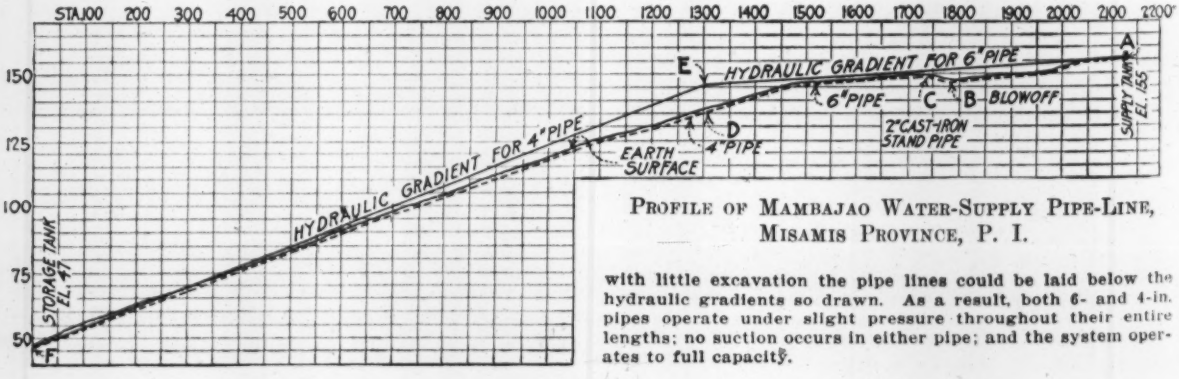
SIMPLE CRANE ATTACHMENT FOR TURNING FLASKS IN A FOUNDRY

endless chain passes over a pulley hung on the beam by rings which can be moved to any beam-notch desired, according to the width of the object to be handled. In operation the chains are looped around the object and a man pulls on each chain on the side toward which the object is to be turned. Being extremely convenient and easy to operate, this [illegible]ching device may be found serviceable elsewhere than in foundries, e.g. in contractors' equipment and the like.

Cheap Drainage Ditching—In straightening and [illegible]dging the old channel of Mauvaisterre Creek, in the Ma[illegible]terre Drainage and Levee District, Morgan County, Ill., [illegible]re-markably efficient work was accomplished with [illegible] small dredging outfit. The new ditch was 5.3 miles long and [illegible]osed the old channel in 22 places. The drainage channel [illegible]con-structed is 20 ft. wide at the bottom with side slop[illegible]. The average depth is 8 ft. The total yardage of ex[illegible]vation was 202,440, and the contract price was 7.49c. per cu.yd. From careful cost data kept by the engineers in charge, [illegible] Caldwell Engineering Co., of Jacksonville, Ill., it is estim[illegible] that the contractor cleared a profit of 2.75c. per cu.yd., [illegible]ding in the cost estimate interest and depreciation, clearin[illegible] right-of-way, a proportion of the overhead expenses, boa[illegible] and lodging of men and all labor and repairs. The dredging was done with an American Steel Dredge Co. 1½-cu.yd. dipper dredge on a hull 72 ft. long, 22 ft. wide and 8 ft. in depth. The dipper boom was 55 ft. long. The contractors were Chapman Bros., of Celina, Ohio.

To Remove Eraser Fragments—To remove pencil marks from tracing cloth after completing a drawing in ink, the draftsman invariably uses a soft cleaning eraser. The problem is to remove the sticky particles of the eraser which adhere to the drawing. The writer has for some time used with success the following method: A small amount of chalk is scattered over the eraser fragments; this chalk readily combines with and dries up the eraser particles which may be either shaken from the tracing cloth or easily removed by a brush.—H. S. Jacoby, Welland, Ont., Canada.

The Reconstruction of a Water-Supply Pipe-Line to correct a peculiar error in the original design is described by G. C. Stroebe, Hydraulic Engineer, Bureau of Public Works, Philippine Islands, in "Quarterly Bulletin" of the Bureau for October, 1914, as follows: The Mambajao pipe-line was laid some years ago with 4-in. soil pipe in a shallow trench from A to F (see accompanying sketch). The records show that when the valve at A was first turned, no flow occurred at F. Finally a hole was drilled in the pipe at C, freeing the "air-bound" pipe from the accumulation of air which had collected at the summit, after which some water issued from the pipe at F. But the pipe never operated to capacity; a person at the air vent at C and at the outlet at F could observe that the pipe was only partly full at those places. It is quite apparent that if it were practicable to have laid the pipe in a straight tunnel bored through the hill from A to F the pipe would have run to capacity and have been without pressure from within or without. If the pipe were laid below such a line, AF, it would have run to capacity and have been under pressure also. But being laid above the straight line AF, the pipe was in suction, and since the joints of the soil pipe were leaky, air found its way into the pipe, causing the pipe to act simply as a trough. It is apparent that a 4-in. trough laid from A to D would not bring the water to D so rapidly as a 4-in. trough laid on the steeper grade from D to F would take it away from D; hence the phenomenon of small discharge in the pipe. This condition would not have occurred if the pipe from A to D were 6-in. instead of 4-in. The hydraulic gradient for such a combination of 6- and 4-in. pipe works out as shown in the accompanying sketch. A calculation shows that when the 6- and 4-in. lines are running to capacity about 9 m. of head are lost in frictional resistance in the 6-in. pipe up to point D. By platting a point E vertically over D and 9 m. in elevation below the supply tank, EA and EF become the hydraulic gradients of the 6-in. and 4-in. lines, respectively. It is seen that



PROFILE OF MAMBAJAO WATER-SUPPLY PIPE-LINE, MISAMIS PROVINCE, P. I.

with little excavation the pipe lines could be laid below the hydraulic gradients so drawn. As a result, both 6- and 4-in. pipes operate under slight pressure throughout their entire lengths; no suction occurs in either pipe; and the system operates to full capacity.

Editorials

The railway companies of Pennsylvania and New Jersey are appealing to the legislatures of those states for the repeal of the so called "full crew" laws. It is stated that these laws add about $2,000,000 a year to the operating expenses of the railway lines in these two states in payment of wages of trainmen required to conform to the law but not required for the safe operation of the trains. In this appeal, the railway companies should have the hearty support of every good citizen. The invention of the air brake by George Westinghouse and its general application to freight trains more than twenty years ago removed any excuse that might possibly have existed for the passage of such laws had freight trains continued to be operated with only hand-brake control. The pretense under which the laws were enacted was that they were necessary to protect the public safety; but no substantial proof has ever been offered that the additional brakemen made necessary add anything to the safety of train movement. These laws have been enacted by state legislatures at the demand of the railway trainmen's organization. The $2,000,000 required to pay the wages of the brakemen who perform no useful service must in the long run be paid by freight shippers and travelers. The effort to repeal these laws, therefore, is really an effort in the public interest.

A Wonderful Road Machine

Readers of ENGINEERING NEWS have noted, since the beginning of the new year, the space given at the end of the reading pages to short descriptions of the more important and interesting commercial novelties under the heading, "Appliances and Materials." It is obvious that not all new developments can be properly described here in the somewhat limited space that can be allotted to any one of the very numerous items received. Also at times we may see fit to reserve space elsewhere for apparatus of striking novelty and magnificent possibilities. Our attention has just been called to a road machine which can be so described, and we here draw our readers' attention to it with confidence in the interest which will be aroused. We need do no more than to quote the Seaside, Ore., *Signal* of Feb. 4, 1915:

> **Alex Duncan, the expert road builder of Seaside, has about completed plans for a road machine that will revolutionize road work. * * * The machine in question, so Alex states, will plow up the road, grade and grub the right of way; all stumps will be carried on an endless chain through a hopper that will grind the wood into a pulp, press this into blocks for wood paving; and the extract of juice from the wood will be manufactured into denatured alcohol, that will be used in furnishing fuel for the engine that will propel the machine along the highway while at work.**

Granite Block Pavements

Experience with granite blocks, perhaps the best and oldest paving material known, extends over a longer period than with any other modern type of city pavement, and the majority of paved city streets are probably covered with this material, at least in the cities of Europe and the Eastern cities of this country. And yet, in this day when volumes are written on testing paving materials, the least is known about the means of determining what makes a good granite-block pavement.

There is a very wide divergence of opinion as to what constitutes a good granite for paving blocks, a great difference in the methods of testing the stone, and decidedly opposite opinions as to the best joint filler. The depth and size of blocks vary greatly, and the width of joint and other things of perhaps lesser importance are open to discussion.

Practically none of the standard text and reference books on pavements are specific as to the kind or quality of granite best suited for pavements, although they are in general agreement that the very hard granites are unsuitable. To attempt to be specific, with the present recorded knowledge of stone paving blocks, leads to rather confusing statements, such as this (from a well known textbook):

> **A quartoze granite, one in which the quartz predominates, is too brittle for paving purposes; a feldspathic granite, one having an excess of feldspar, is too easily decomposed; and a micaceous granite, one containing considerable mica in parallel lamina, is too easily split for use in paving blocks. Gneiss is usually too much stratified to make a good paving material. Syenite is one of the best materials for paving blocks, and usually the darker the color the better the stone.**

How much is an excess of quartz? of feldspar? of mica? Who can answer these questions definitely? "A micaceous granite, one containing considerable mica in parallel lamina is too easily split;" it is very desirable to use a granite that splits easily, if regularly shaped blocks are to be obtained economically. What is syenite as distinguished from what is ordinarily called granite? How may the paving engineer know how to distinguish between the two? These questions require answers based on careful study and comparison of notes by engineers of long experience.

The old-fashioned crushing test of granite cubes is now generally admitted to be useless as an index of the value of the stone for paving blocks. The adaptation of the Deval abrasion test, or the standard rattler test now universally used for paving brick, is feasible, and such tests are sometimes made, but no generally accepted standards have been found for granite blocks. Paving engineers state that the most reliable test at present for granite blocks is that for toughness by means of the Page impact machine.

As to joint filler, the practice seems to be for one city to adopt cement grout and use it for no other reason than that according to local judgment and experience it is best. Other cities, notably the Borough of Manhattan, New York, use bituminous filler exclusively. The chief argument in favor of bituminous filler is the ease with which the pavement may be torn up and replaced, and a less noisy pavement is claimed.

Objections to cement grout are the slipperiness if the grout covers the entire top of the pavement, and the difficulty of making an opening in the pavement. The objections to bituminous filler are that it seldom or never com-

pletely fills the joint; if the blocks are cold the filler congeals before reaching the bottom of the blocks; on hot days the filler sinks farther in, and an open and unsanitary joint is the result.

Unless great care is taken, not only to obtain smooth-faced blocks, but also to see that they are laid with as close joints as possible, the advantage of the more expensive block is lost. The object of a dishonest contractor is to make the blocks cover as much yardage as possible, and often the joints are not so close as they could be made. Wide joints with bituminous filler inevitably result in the "turtle-back" blocks, which are so objectionable.

The fact must be recognized also that neither one nor the other of these two kinds of filler is adapted to all kinds of granite or to all kinds of traffic conditions. Where the traffic is only moderately heavy, a stone showing a low coefficient of wear by the Deval test may be laid with comparatively wide joints filled with cement grout and give far better satisfaction than the same pavement with bituminous filled joints, or a pavement of high-coefficient granite with close but grouted joints. So far as we know, no one has attempted to draw a line between the two practices based on the Deval test, but W. A. Howell, Engineer of Streets and Highways of Newark, N. J., has drawn this conclusion based on tests with the Page impact machine:

> On heavy traffic granite-block pavements where the traffic cannot be shut off sufficiently long after grouting and during the cement-setting period, and on granite-block pavements where the impact tests on the granite show a figure as high as 13, cement grout should not be used at all, but tar and gravel filler should be substituted.

Newark has had a longer experience with modern granite-block pavements laid under a ⅜-in. joint specification than any other city. This practice was established there in 1908 by Morris R. Sherrerd, Chief Engineer of the Board of Street and Water Commissioners, and since then 18 miles of close-jointed grouted granite-block pavement have been laid.

Mr. Howell is also authority for the following note on Newark experience:

> Under Mr. Sherrerd, the ⅜-in. joint was given a thorough trial, with both fine-grained and coarse-grained granite blocks, and it was found to be practically impossible to carry the specifications into effect with coarse-grained granites.

As to the size of blocks and the strictness with which they must conform to specified dimensions, there are many opinions. A depth of 5 in. is now being generally adopted for the close-jointed blocks, although in Worcester, Mass., blocks 4 in. deep have been used with success on the lighter-traffic streets; and there are many advocates of the 4-in. cube blocks, generally known as "Durax" blocks.

Since granite-block pavements are again coming rapidly into favor for heavy-traffic streets, a more thorough understanding of the elements of a good granite-block pavement is increasingly essential. The tendency is too much to regard the blocks, like brick, as a manufactured product and to draw specifications accordingly; while the problem before the engineer is first to study and know the particular kind of granite he is to use, then to draw specifications to fit and not to attempt to make blanket specifications covering any and all granite blocks. But while the problem has and always will have these local factors, the need of standard tests for granite and of rules for good practice to meet the various traffic conditions is none the less pressing.

Damage Done to Road Surfaces by Automobile Tire Chains

Any inventor who will produce and put into extensive use some attachment to automobile tires which will secure traction and avoid side-slip on soft or slippery roads and which will at the same time do less damage to the road surface than the present tire chains will not only bestow great benefit on the automobile industry, but will save millions of dollars of damage now being done to road surfaces. The destructive effect on water-bound macadam roads of smooth automobile tires is now universally admitted; but it has been generally claimed that the best-built bituminous macadam roads were proof against such damage. When, however, a heavy, high-speed automobile has chains put on its tires, it is manifest that only the hardest and toughest road surfaces, such as granite block, vitrified brick, sheet asphalt, wood block or concrete, can be expected to resist the wear.

In Boston and vicinity last week a thaw left the roads covered with several inches of ice, making it absolutely necessary to put chains on all motor-car tires. Almost immediately ruts were worn through the ice down to the road surface beneath and all motor cars had to follow in these ruts, which, as the temperature was slightly above freezing, were constantly filled with water. The road surface underneath was more or less weakened by the effect of the water and under the attrition of the tire chains, the ruts were rapidly deepened and the broken stone of the macadam was scattered over the surface of the road.

Such weather conditions are liable to prevail at any time during the winter months, and are bound to result in serious road damage. What highway authorities in charge of road construction and maintenance can do to protect their roads is an exceedingly difficult question to answer. An ordinance forbidding the use of chains on automobile tires would be impracticable, for such equipment is a necessity when the roads are covered with ice if the machines are to run at all, not only for the safety of the cars using the chains, but for the safety of all other road traffic. Doubtless the damage to road surfaces would be less severe if tires were equipped with the well known leather armor with steel studs; but this protection is quite expensive, not readily applied and removed and does not give the amount of traction and security from side-slip which the chains afford.

Although the rutting of roads by automobile tires is much more rapid on gravel and dirt roads than on macadamized roads, the injury there is comparatively unimportant since the ruts can be smoothed out by the use of scrapers and rollers and the roads made good as new. On a macadam road surface, however, when the ruts are torn out by automobiles, it is generally necessary to pick up a broad strip of the entire surface and apply considerable new material to bring the road again into proper shape, which procedure is necessarily a very expensive process.

The whole matter is one which is bound to receive more attention than ever before by highway engineers due to the increasing use of commercial automobiles, which are run all the year round when roads are often in poor condition to resist wear, whereas pleasure cars are little used except in pleasant weather when the roads are in good condition.

Letters to the Editor

On the History of Steel Tapes

Sir—In ENGINEERING NEWS of Dec. 31, 1914, p. 1316, is an article on the history of steel tapes, in which it is stated that they were introduced into this country about 1870.

In Crushing & DeWitt's office, in Providence, R. I., in which I started, the boys in the office were in the habit of making their own steel tapes as far back as 1864, and how much farther back I do not know, but I believe it must have been several years.

The firm used to buy hoop-skirt steel tape of exactly the right thickness. This we cut into lengths of something over 100 ft. to allow for loops at the ends, through which were passed stout cord. At intervals of each foot we dropped solder about ½ in. in length and about $\frac{1}{16}$ in. in thickness, and then from a standard measure, made strongly marked lines across the tape and punched the figures.

I have never seen better tapes or stronger, and I later introduced them into my practice in the West. We carried a rule to ascertain tenths and hundredths.

All this makes me think that I am getting to be an old man.

DESMOND FITZGERALD.

Brookline, Mass., Jan. 30, 1915.

An Estimate for a Tubular Bridge for the Mexican Ry.

Sir—Referring to the interesting editorial on the history of the Victoria tubular bridge at Montreal, in your issue of Jan. 28, it may be of interest to know that a tubular bridge was proposed in the late 50's for use on the Mexican Ry. line from Vera Cruz to the City of Mexico. I quote from a report made by Capt. Andrew Talcott, Chief Engineer, in 1858.

> Between Cordova and Orizava is a deep barranca known as the Barranca de Metlac, which was found to be 1085 ft. wide at the grade line 340 ft. above the stream. The rock on the west side slopes about 45°, and the eastern slope is still steeper. It is a fine site for a suspension bridge, and if that kind of structure was not very objectionable on railway lines I should recommend the construction of one at this point. A better but much more expensive plan would be an iron tubular bridge of two or three spans resting on piers formed of cast-iron tubes, which would be cheaper than masonry. A pier of masonry 346 ft. in height in the Barranca de Metlac would cost $225,000. One of cast-iron columns under a permanent compression of 1 ton per sq.in. would require 1875 sq.in. of iron at the bottom and 1500 at top, equal to two tons per foot of height, or in round numbers for one pier of cast iron, 1000 tons, which I estimate can be purchased in Liverpool all fitted for £9000.

It will be seen that according to Captain Talcott's estimate, his cast-iron pier completed and ready for shipment at Liverpool would cost only one-fifth as much as a masonry pier, notwithstanding the fact that he had assumed the astonishingly low unit loading of one ton per square inch for the cast iron and the generous price, according to our present day standards, of $45 per ton for the material. Accompanying Captain Talcott's report is a letter by William Fairbairn on the cost of a tubular bridge for the Mexican Ry., from which I quote as follows:

> Manchester, Nov. 26, 1858
>
> Sir: In reply to your letter of 3d I have to refer you to the annexed pen sketch of the bridge I would propose for crossing the ravines or rivers on the line of railway between Vera Cruz and Mexico. I assume that in crossing these valleys it will be a single line of rails, and should this be the case the following will enable you to form a correct idea of the cost of the ironwork forming the superstructure:
>
> Tubular bridge of 400-ft. span, prepared in sections and delivered in Liverpool ready for reconstruction, including all the plates, bolts, rivets and expansion apparatus, the whole complete about 1250 tons, £26,500.
>
> The computed strength of these tubes will be 8 tons per lin.ft., or 3200 tons for the 400-ft. span.
>
> Yours sincerely,
>
> (Signed) WM. FAIRBAIRN.
>
> M. E. Lyons, Esq., C. E.

The letter also gave estimates for a three-span bridge, 1000 ft. long.

It will be seen that the price for the fabricated plates for the tubular bridge was a little over 5c. per lb., and also that the weight of the 400-ft. span was a little over three tons per lineal foot and that it was supposed to have a strength of eight tons or about 17,000 lb. per lin.ft. It is probable, however, that ultimate strength and not working load was meant by the term "strength" in the above letter. The project to build the tubular bridge for the Mexican Ry., however, was never realized. The following is an extract from the diary of Sebastian Wimmer, an engineer of the Mexican Ry., dated Apr. 26, 1866:

> Demonstration, dinner, dance, etc., at laying of the cornerstone for big bridge over Metlac Barranca. The project for a bridge 900 ft. long and 300 ft. high has had to be abandoned for a 125-ft. wooden trestle on account of earthquakes which might have destroyed such a high structure.

Accompanying Fairbairn's estimate were rough sketches of the proposed spans and piers; but no hint is given of the method by which the tubular bridge could have been erected. The sketch merely shows a cross-section of the gorge with two slender piers 350 ft. high supporting a central span of 400 ft. and two side spans of 317 ft. It is doubtful whether any practicable method could have been devised to erect the bridge.

E. M. L.

Buffalo, N. Y., Feb. 5, 1915.

On Allowing for Irrigable Lands Not Irrigated

Sir—In estimating the available water-supply for an irrigation project, it is the practice among engineers to make an allowance for irrigable lands not actually irrigated. In some cases as high as 20% is allowed for this class of lands. It is then assumed that the water otherwise required for these lands could be applied to other lands. For example, if the water-supply is found to be sufficient for 20,000 acres, and the 20% allowance is made, it is assumed that the water will supply a 24,000-

acre project. In this example I have purposely taken the maximum allowance that has come to my notice, 20%, in order to bring out more clearly the point in mind. The question as to whether any allowance should be made and, if any, what per cent. should be allowed, has resulted in several more or less serious controversies in Oregon. In one case the water rights involved had a sale value of $200,000. It must be kept in mind that the allowance is made after all the nonirrigable land has been eliminated.

During the first few years after the construction of the irrigation works, much of the land is not irrigated because it requires considerable time for the farmer to prepare his entire tract for irrigation. However, after all land has been irrigated, or sufficient time has elapsed so that under ordinary conditions the land would have been irrigated, the nonirrigated land may be divided into three classes: (1) Land belonging to nonresidents, and not rented; (2) summer fallow; (3) land occupied by buildings and fences.

It may be said of the first class that, as the land owner is paying from $0.40 to $2.40 per acre per annum, as well as interest on the cost of construction and taxes, it is not likely that he will permit the land to lie idle for any great length of time, and this class of lands will doubtless gradually diminish until it is entirely eliminated. The original cost of construction, coupled with the annual maintenance charges, makes it too expensive to hold land in an irrigation project long for speculation without receiving some return.

Summer fallow is not as common on irrigated lands as upon dry farms, crop rotation being used as a substitute. This is largely due to the fact that different kinds of crops can be raised, and also on account of the necessity of securing some returns from the irrigated land every year to meet expenses. It is doubtful whether summer fallow can be properly classed as nonirrigated, as such land is frequently irrigated to facilitate early plowing or seeding.

A very small part of the lands is occupied by buildings, and the area surrounding the buildings is usually watered. The land occupied by fences is comparatively insignificant. Roads are an important item in an irrigation project, especially a project upon which the tracts are small. Allowing for 60-ft. main roads every mile and 40-ft. cross roads every half mile, about 2½% of the total area would be taken up with roads. This would allow for a county road in front of every 40-acre tract, and a main highway within half a mile of all such tracts.

Don H. Bark, in charge of joint investigations as to duty of water under the U. S. Department of Agriculture and the State of Idaho, finds from actual survey that only 8.06% of the irrigable land in an irrigation project is not irrigated. Mr. Bark says:

> **The survey includes everything, that is, every square foot of an irrigated area totalling 16,065 acres.**
>
> **The waste, or nonirrigated acreage contained in the area surveyed, consisted of 1294.52 acres, or 8.06%, which was made up of: Corrals, 0.62%; barn and stock yards, 0.16; fence rows, 0.55; sloughs, 0.28; creeks, 0.61; canals and ditches, 1.43; roads, county and private, 2.18; railway rights-of-way, 0.58; coulees, 0.57; building sites, 0.86; high ground, 0.02; miscellaneous, 0.20%.**
>
> **This land was typical Idaho irrigated land consisting of two tracts, one in the Boise Valley, the same having been cultivated about 10 to 15 years, and the other was located on the south side of Twin Falls Project, having been under cultivation eight years.**

It will be noted that this includes all land not act... in cultivation, such, for example, as the small are... waste land along the fences. Such area could not be e... inated in fixing the amount of water the irrigator i... titled to, as it will subirrigate and furnish pasture. ... is therefore irrigated. If, therefore, any allowanc... made it should be 8 rather than 20%.

In addition to the practical problems involved, t... is the legal aspect of the case. If a land owner bu... water right for 40 acres of land, and pays the annual m... tenance therefor, under what conditions can he be ... prived of a delivery of the quantity of water determi... upon as sufficient for the irrigation of the entire tr... The possibility of a natural shortage is recognized, ... most irrigation contracts make provision for a proporti... al division of the water. I believe that this is the o... case in which it would be equitable to cut down t... water-supply when a contractor demanded his full d... livery according to contract. While beneficial use is the usual measure of the right, the amount which can be beneficially applied is determined at the time of the sale of the water right. The irrigator certainly has a right to determine how he shall irrigate and whether or not he will summer fallow his land. Even if actual beneficial use did fix the amount of water to which an irrigator was entitled each season, who would have the right to determine what would constitute beneficial use? Having paid for the use of the commodity and the delivery of it, the irrigator is entitled to it.

Due allowance should be made as far as possible before the cost is assessed and no charge made for the irrigation of roads, which the farmer would not be allowed to irrigate. It is difficult to say what disposition should be made of water rights appurtenant to land later included in roads. Should the water rights belong to the county, which has a possessory right to the land, or should the water rights remain the property of the original land owner to whom the land will revert in case it is abandoned for road purposes; or should they revert to the ditch owner and be sold a second time; or should they follow the rule of abandoned water rights, and inure to the benefit of subsequent appropriations? The answer to this question will depend largely upon the laws of the state, but as a matter of equity and practical administration, the water rights should remain the property of the land owner.

The writer questions the legal right of any company, irrigation district, water users' association or other organization in control of the delivery of water to deliver a less quantity of water than that purchased and for which maintenance is being paid, regardless of the conditions of the land to which such water is appurtenant. We have no quarrel with the practice of designing irrigation projects with an anticipated periodical shortage of water, provided that such shortage is not increased by the addition of a certain area on account of the anticipated nonirrigated irrigable land. This matter should be given consideration at the time of fixing the duty of water.

In conclusion, the writer believes that if a given water-supply is found to be sufficient for 20,000 acres, water rights should be sold for 20,000 acres and no more; hence, that the cost should be assessed against the same area.

PERCY A. COOPER,
Assistant State Engineer.
Salem, Ore., Nov. 20, 1914.

Paints Which Resist Darkening by Gases, Soot, Etc.*

By Henry A. Gardner†

Effect of Gases Evolved by Polluted Waters

During an automobile trip along the banks of the Passaic River at Passaic, N. J., last November, the writer passed hundreds of frame buildings, nearly all in an unsightly condition. Comparatively new structures were as bad as old ones. It was evident that hydrogen sulphide gas from the river was responsible.

The action was most severe on freshly painted surfaces, which exhibited large areas of bluish-black deposit with metallic luster. The greatest darkening was indicated on the soft, rough sections of the wood where the oil had been absorbed, leaving but little binder for the pigment.

At one house with unaffected white trim, inquiry showed that a prepared paint containing zinc had been used. Probably this added to the gloss of the coating; also it is known that zinc white is not affected by hydrogen sulphide. Some tests of panels bearing three hardened coats of various white paints, exposed to this gas, showed that the use of over 10% zinc oxide largely prevented action on the lead pigment; 10% of inert pigment also gave good results.

Effect of Industrial Smoke, Soot and Gases

Houses in Pittsburgh must be painted *for the sake of appearance* twice as often as in most other cities. However, some paints apparently last longer (protect the painted structure longer) there than in many other places, due partly to the protective action of accumulated soot. Among some panels on a Pittsburgh test fence, now some seven years old, considerable difference is seen in the resistance of various pigments to the accumulation of soot. Simple-pigment paints which weathered soft and rough became good holders for soot and tar, which hardened to an unwashable surface. The paints which contained lead with zinc or other pigments dried with harder and glossier films and did not retain as much dust—or at least were washed fairly free by rain.

Analyses of the surfaces of these panels showed that 50% of the all-lead-carbonate surfaces had been converted to sulphate; the sulphur-laden rain was easily absorbed by the rough soot-coated paint. The carbonate surfaces held 2.1 to 6.6% insoluble matter, 1.4 to 2.7% iron oxide and 12.8 to 32.6% carbon and organic matter. It is interesting to note the high percentage of iron oxide on the panels which had no iron in the paint; an average of 3% and a maximum of 18 were found. However, the percentage of iron dust is small in comparison with carbon and organic matter present. The tar compounds act like mucilage and a coating with cinders offers a great resistance to washing. An efficient cleaner has been found in a neutral-soap solution containing a little kerosene and finely divided silica. The writer has not been able to confirm generally the statement of a contemporary that sulphur-dioxide gas converts zinc oxide into soluble zinc sulphate. (The lead-zinc paint surfaces were less washable and not so satisfactorily examined.)

Durability of Paints Exposed to Railroad Cinders

The writer has often observed the excellent condition of paints used on small frame railroad stations about the country. Inquiries developed the fact that in most cases the base of the paints was white lead (basic carbonate or basic sulphate) and zinc oxide, ground by machinery to a paste in pure linseed oil and subsequently thinned. Moderate percentages of inert pigments have been used in some of these paints with good results. It is probable that a good percentage of hard pigments is desirable and that pure oil with high-grade dryer should be the thinner, to form a quick-drying and fairly hard coating. Otherwise cinder darkening may occur.

In one case some white station sign boards had turned very dark. Microscopical examination showed that the paint was in most excellent condition except for small imbedded particles of coal cinders and iron oxide. The paint had evidently been applied without dryer.

*Based on parts of a paper, "Observations on Painted Lumber," before the International Association of Master House Painters and Decorators, Washington, D. C., Feb. 9, 1915.

†Assistant Director, Institute of Industrial Research, Washington, D. C.

Report on a Break in a 60-In. Water Main at Cincinnati

Longitudinal compression, due to contact of portions of the ends of pipe lengths at joints, is given as the cause of the break in a 60-in. force main in Eastern Ave., Cincinnati, Ohio, on Dec. 6, 1913,* by John W. Alvord, Consulting Engineer, of Chicago. This conclusion was expressed in a report made by Mr. Alvord to the Marquette Construction Co., of Chicago, in behalf of that company and the Pennsylvania R.R., the company having been engaged at the time of the break in laying a 24-in. drain pipe near the water main in connection with railway grade elimination work for the railroad.

Mr. Alvord visited the scene of the break a week after its occurrence and interviewed the superintendents and engineers for the contractor, the railroad and the city. He also studied the evidence taken by the coroner's jury in its investigation of the death of three men who were drowned in the drain trench at the time of the break. Mr. Alvord's report is dated Sept. 15, 1914, but has only recently been made public, owing to litigation over the break. One of the current explanations of the cause of the break was that it was due to the drain excavation which has been mentioned, but Mr. Alvord believes that work had nothing to do with the case.

The main which broke was nearly parallel with the Pennsylvania tracks, and 20 ft. distant at the point of the break. The bottom of the main at the point of the break was 15½ ft. below the street surface. The drain-pipe excavation was partly in trench and partly in tunnel, each sheeted and braced. The sheeting was nearly 2 ft. from the water main and the bottom of the excavation was on the same level as the bottom of the main. The excavation was in "fairly stiff shaly clay." Heavy railroad trains and interurban trolley cars pass the site of the break, the double tracks of the trolley line being on the other side of the pipe from the railroad, and one rail being quite near the main. At the time of the accident the ground was partly frozen.

About 150 ft. from the break, and in an abutment to the subway for the street undercrossing, there is a vertical bend in the 60-in. main. This bend is embedded

*See "Eng. News," Dec. 11, 1913, p. 1208, and Jan. 29, 1914, p. 275.

in concrete. The bend and the anchorage together "evidently hold the pipe at this point from either marked longitudinal or lateral movement, while to the east of this point, in the direction of the rupture, there is more opportunity for the lateral and compressive thrust to be brought into play." The pipe line along this stretch was curved convexly toward the "railway and bluff side of Eastern Ave." at the rate of about 3 ft. offset per 100 ft. for some 400 to 500 ft. When the pipe broke, a piece about 8 ft. long, constituting a half of the circumference of the pipe at the bell, was forced outward, toward the railroad tracks, and away from the convex side of the curve.

Examinations of the fracture indicated good sound material. Tests of the piece of pipe broken out, made under the direction of John W. Hill, of Cincinnati, Mr. Alvord states, "show no cause for any criticism of the material of which the pipe was made." Mr. Hill examined the "interior of the pipe for over 100 ft. east of the break at the time of its repair," but could not examine it to the westward "on account of standing water in the depressed section of the pipe." Mr. Hill has stated:

> The ends of all spigots at some point in the circumference had been butted up, metal to metal, against the shoulder of the bell, and under this condition of pipe laying, motion of the pipe in any direction might produce stresses in the spigot or bell, beyond those that the pipe could resist, and of a kind not anticipated in the design of the pipe.

On Sept. 13, 1914, a break occurred in a 48-in. water main, in Columbia Ave., Cincinnati. Regarding this break Mr. Alvord says:

> E. E. Stetson, an engineer, who had opportunity to inspect both breaks, reports to the writer that the recent break was similar to the one in the 60-in. main on Dec. 6, 1913, at Eastern Ave. A section of pipe was broken out of approximately the same size and shape, and in both cases the bell of the pipe broke exactly in the middle of the pipe at top and bottom. The recent break in Columbia Ave. tapered in wedge shape to within 1½ ft. of the next joint, and this pipe was laid in a rock cut, with nobody working about it.

The conclusions of Mr. Alvord's report are as follows:

> (1) That the 60-in. main was ruptured by longitudinal compression; that is to say, pressure acting along the direction of the center of the pipe line, and splitting a section out probably where some portion of a spigot-end bore on the shoulder of the bell-end.
>
> (2) That the pipe line was thrown into longitudinal compression in large measure because the barrels of the pipes were in contact at some point in their circumference at the joints. This may have resulted from lack of end clearance in laying, or it may have resulted from closure, since laying, by lateral pressure from the north or bluff side of the pipe.
>
> (3) The longitudinal pressure was possibly increased by the fact that all secondary influences, such as jar from trains, pile driving, landslips, occurred on the northerly side of the pipe, which side presented a slight convex curve in that direction all along the pipe line, on both sides of the break.
>
> (4) The particular influence which increased the longitudinal pressure to the rupture point can hardly be identified; it probably was not a large force, taken by itself. Any increase of land pressure or of accumulated jars would have been sufficient, in the strained condition of the pipe line, to have compelled the final rupture.
>
> (5) It is not conceivable, from an engineering point of view, that the sewer trench could have been even the completing cause of the rupture. The trench was fully braced and did not reduce the supporting lateral pressure of the earth against the main. Its depth and position were not such as to cause even conservative criticism. There was no hammering of sheeting going on at the time of the rupture. The more plausible explanation is that the jar of a passing train or an increase of lateral thrust from the sliding bluff added the final few pounds of stress, which, in connection with the strain already present, caused the final break, and the fact that the trench for the drain was open at that ... only be regarded as an unfortunate coincidence.
>
> (6) If the theory above outlined is correct, it is ... that some danger yet exists of another break in this ... unless the sleeve and short length used in the re... so laid as to provide for play in the length of the pip... protecting effects of such play in the length of the pip... very far from its immediate vicinity.

Expansion Measurements of Concrete Factory Building

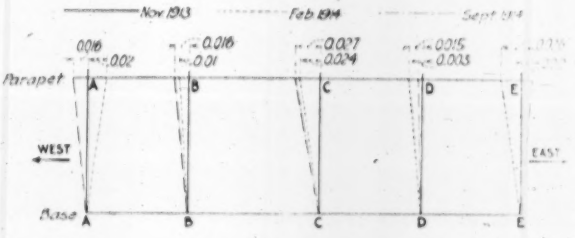
Very careful measurements of the Gray & Davis ... in Cambridge, Mass., were made, shortly after completion of the building, by Professor Howard of the Massachusetts Institute of Technology. The builders, Abertha... Construction Co., Boston, wanted the basis for a study of the expansion and contraction of a reinforced-concrete building under temperature variations. The over-all lengths of the building and the movements of vertical lines established on the south front were measured.

Measurements were made Nov. 7, 1913—a moderately warm day; Feb. 12, 1914—a cold day; Sept. 1, 1914—a hot day.

The varying lengths of the building, measured between points accurately established near the two ends, are given in the accompanying table. In each case the measurement given is the average of several determinations.

Date	Temperature, Deg. F. Base	Roof	Length, Ft. Base	Roof
Nov. 7, 1913	69.8	56.9	382.559	379.427
Feb. 12, 1914	17.4	6.2	382.552	379.377
Sept. 1, 1914	90.0	82.0	382.580	379.483

The shrinkage in the base with a difference of temperature 52.4° is apparently 0.007 ft. At the roof with a



difference of 50.7° the shrinkage was 0.06 ft. Comparing September with the previous November the base had expanded 0.021 ft. with a 20° increase in temperature, and the roof 0.046 ft. with a temperature difference of 25°.

The movement of the points located on the parapet, as compared with the points at the base (which may be considered as fixed), is shown by the sketch herewith. It might be mentioned that the September measurements were made almost exactly one year after pouring concrete was finished. A curious feature of the results shown by the sketch lies in the fact that the four sections of the building between measuring points expanded and contracted irregularly. When the building contracted as a whole, one section of the building showed actual expansion, and *vice versa*. This must have been due to local causes which have not been determined—possibly to interior conditions of heating.

*From Sidney G. Koon, with Walter B. Snow, 136 Federal St., Boston, Mass.

Mid-Winter Convention of the American Institute of Electrical Engineers

The third mid-winter convention of the American Institute of Electrical Engineers was held in the Engineering Societies' Building, New York, Feb. 17-19, with a total attendance of about 450. The program was of a general nature, one session being devoted to a discussion of testing high-tension insulators, another to miscellaneous high-tension work, one to electric motors, one to the electrical precipitation of suspended matter in smoke and fumes, and one session was given up to a discussion of the broad question, "The Status of the Engineer." There were various excursions to electrical engineering works, and a dinner dance.

The discussions on "The Status of the Engineer" are reviewed elsewhere in this issue. Probably the greatest interest of the whole meeting centered in the session at which three papers were presented on "Electrical Precipitation of Suspended Matters in Fluids". The first paper, entitled "Theory of the Removal of Suspended Matter from Fluids", was by W. W. Strong, of the Mellon Institute of Industrial Research and School of Specific Industries, University of Pittsburgh. The way was outlined in which the amounts of energy required for precipitating suspended matter had been figured for the installations which had been studied at the Mellon Institute. This was according to Stokes' law for the force required to overcome friction of movement of suspended particles; application was shown to the use of high-tension electrical discharge (corona). The statement was made that approximately 10% of the electrical energy was used directly in precipitating dust, etc.; it was expected that this figure could be increased.

The second paper, entitled "Theoretical and Experimental Consideration of Electrical Precipitation", by A. F. Nesbit of the University of Pittsburgh, was a general review of modern views regarding the atomic structure of matter and the ionization of gases with particular reference to the bearing on electrical precipitation of smoke, dust, ashes, etc.

The third paper, "Practical Applications of Electrical Precipitation," by Linn Bradley of the Research Corporation (which concern is administering the patents for the Cottrell electrical precipitation process and turning the proceeds over to the Smithsonian Institution for research promotion), was of a generally practical nature and was illustrated by moving picture films, and lantern slides of the work done at the Selby, Balaklala, Garfield and other smelters. A wide application was shown to much commercial work with smelter fumes, chemical mists, powdered food products, etc.

In opening the session at which these papers were presented, F. V. Cottrell, of the U. S. Bureau of Mines, inventor of the process whose developments were described, reviewed the work of earlier investigators who made his own system possible—special credit being given to Sir Oliver Lodge. In speaking of the possibilities of the process, he mentioned the possibility of carrying to completion, with the apparatus and methods now available, Lodge's scheme of dissipating fog. He thought that it might be possible to sweep a path ahead of a fogbound vessel carrying, by aerial sustentation, a system of electrodes a couple of boats' length ahead of the vessel.

The Status of the Engineer

One session of the midwinter meeting of the American Institute of Electrical Engineers last week was devoted to a discussion of the status of the engineer by the following well known engineers: L. B. Stillwell, Past-President of the Institute; E. Wilbur Rice, Jr., President of the General Electric Co.; Edwin M. Herr, President of the Westinghouse Electric & Manufacturing Co.; Dr. Alex. C. Humphreys, President of Stevens Institute of Technology; Prof. George F. Swain, of Harvard University; Henry G. Stott, Superintendent of Motive Power, Interborough Rapid Transit Co., New York City, and John J. Carty, Chief Engineer of the American Telephone & Telegraph Co.

THE ENGINEERS' CONTRIBUTION TO CIVILIZATION—Mr. Rice in particular laid stress on the great debt civilization owes the engineer—including under that term all practical scientists. Dr. Humphreys thought too much emphasis was laid upon great achievements like the Panama Canal; the engineer's hand was everywhere in the commonest things of every-day life. Mr. Carty said that progress and advance had been so rapid in the last half century that even engineers themselves had failed to realize their place in our present civilization. Not all this progress has had to do with inanimate material things for, as both Mr. Carty and Mr. Herr pointed out, the greatest steps in the engineering of men—in scientific management—have been made by engineers, or men of engineering training and experience.

SPECIALIZATION THE ORDER OF THE DAY—Mr. Stillwell thought that too much of engineering students' time was devoted to studying details, which could be learned only in practice; more time, he said, should be devoted to the study of the humanities, the studies which have a broadening liberalizing influence. Although other speakers seemed to be in agreement on this point, most of them considered that specialization was also essential to success in engineering. This was most aptly expressed by Mr. Stott, "that each of us could not expect to play all the instruments in the band." A young man should gain his special knowledge, however, in practical work. Dr. Humphreys said that the province of the engineering school was to train him in fundamentals, not in specialties.

ENGINEERS IN PUBLIC LIFE—All the speakers deplored the fact that there are few engineers prominent in public life. There is a popular but unfounded idea that engineers are not good executives, Mr. Rice said. He added that business men were taking a larger part in governmental affairs and engineers should follow the example. Mr. Herr showed how the engineering graduate was entering with success all branches of industry, and particularly the selling branch, where the technical nature of many manufactured products called for salesmen with knowledge of engineering.

While opposed to the present scheme of government by commissions, Dr. Humphreys thought that the engineer was the best qualified of any profession for membership on these commissions, not only because of his judicial attitude, but because the problems to be met were largely technical problems.

Prof. Swain said that although the engineer and engineering were not appreciated, he thought undue emphasis was put on this. Engineers, he said, were as well paid as men of any other profession; the engineering

field was not overcrowded; the business of the engineer, unlike that of men in other professions, did not appeal to any sentiment. Professor Swain said that leadership in public affairs was solely a matter of personality, and if the engineer is not a leader, it is because he lacks the personal qualities to make him a leader. The training of the engineer, Professor Swain held, gave him no advantage over other professions; in fact had rather a narrowing tendency. In his opinion, relief from present governmental perplexities was to be had through the participation in public life of the business man.

LAWYERS VS. ENGINEERS AS LEADERS—Mr. Rice said that an analysis of the membership of Congress in 1914 showed that 75% of the Senators and 65% of the Representatives were lawyers. While he had the utmost respect for lawyers as a profession, the preponderance of lawyers in legislative bodies was an evil. The social and industrial problems of the day need looking into by engineers—men accustomed to analyze and get at the core of things.

Professor Swain failed to see how engineers were better trained for public life than lawyers; the training which tended to develop the qualities of analysis, breadth of view and straight thinking were more emphasized in the education of the lawyer than with the engineer. The lawyer, he said, was trained to pick words to express the exact meaning, while much misunderstanding resulted from the average engineer's want of similar exactness of expression; the lawyer was able to state questions from both the negative and positive points of view, to see the weak points of his own case, while the engineer labored only on one side of a problem; engineers needed mental discipline along these lines; on the whole the ability to reason logically was far more emphasized in legal training than in engineering training. Professor Swain thought that the brightest college graduates entered the profession of law, and that some of these men should be won over to engineering.

Mr. Herr agreed that leadership was far more dependent on personal qualities than on professional training. From his own experience, he knew that the requisite qualities of an executive could be acquired; that the main things were justice and fairness; no man expected more than these from his superiors. Tact, he said, was essential, for it made all the difference in the world how an order was given; in the management of men there was no departure from engineering principles and to acquire the requisite qualities an engineer or anyone else had merely to follow the Golden Rule.

HOW SOCIETIES MAY HELP ENGINEERS—Mr. Stillwell advocated a much larger participation in public affairs of the four national engineering societies. They could do much, he said, by raising the standards of membership and enforcing codes of ethics. Nothing, he thought, would add more to public estimation of these societies than to have dishonest and criminal members publicly expelled.

The four societies should work together as a unit for or against proposed laws which affected their status and their work. Mr. Stillwell urged that committees from the societies should appear more frequently before Congressional and legislative committees. Mr. Stott said that the engineering societies should do more to obtain recognition for the civilian engineers employed by the government; the popular notion, he said, was that the Army Engineers were responsible for all great engineering [illegible].

HOW EDUCATIONAL TRAINING MAY HELP THE ENGINEER—Mr. Stillwell hoped to see the time when a four-year academic course would be required before beginning say a two-year course in engineering; engineering education should be in fundamentals; the preliminary education should include the study of logic, rhetoric and political economy. Mr. Rice said engineering education should, more than any other, tend to develop a man's powers of observation. Doctor Humphreys laid particular stress on the importance of character development in engineering education. The work of the engineering school should not be limited to engineering studies. Education is a continuous process and should not cease with graduation from a college or technical school.

Professor Swain said the status of engineers could be improved by broadening the curriculum of engineering schools, and giving less attention to technical details. Ordinarily the tendency of technical education is to narrow the mind instead of broadening it. He said the human element in the great problems of the day could not be met by a man used to dealing exclusively with mathematical problems; if the engineer were as liberally educated as the lawyer and had the requisite personality, Professor Swain held that leadership would come to the engineer just as certainly as it now goes to the lawyer; and this was the fundamental means of improving the status of the engineer.

A Septic Tank Explosion at Florence, N. C.

BY M'KEAN MAFFITT*

A gas explosion in the septic tank of Florence, N. C., a few days ago, is of considerable interest, even though, for reasons explained further on, it did comparatively little damage.

The sewers of Florence were designed to carry domestic sewage only, but owing to lax inspection, and consequent poor jointing of the vitrified pipe, the wet-weather flow is three to four times as much as the dry-weather flow.

Two main outfall sewers, each about two miles long, converge in a double manhole at the disposal works. These works consist of duplicate sand traps, an ordinary or one-story covered septic tank, a siphon dosing chamber, and sprinkling filters. The effluent is discharged into a small stream and goes thence to a large creek. The heavier solid matter retained in the sand traps is flushed into the small stream at intervals, without causing odor or nuisance. The septic tank has an effective depth of about 8 ft., is baffled, has submerged outlets, and retains the sewage several hours. The filter beds are supplied by means of spray pipes, and consist of 3 ft. of 1½-in. crushed stone, with tile underdrains.

When the plant was put in operation, in May, 1911, the volume of sewage was so small that the plant required but little attention. Apparently, it continued to receive slight attention, for when the writer took charge a little over a year ago the effective area of the tank had been reduced nearly two-thirds by sludge. The sludge was so heavy and viscous that it could not be flushed out by the means provided. As no pump was available, we attempted

*Superintendent of Water and Sewers, Florence, N. C.

to bring the sludge deposit to a level, submerge it and mix sewage with it by means of a pole to which a headpiece was attached. When it had been thus leveled, submerged and made sufficiently fluid, the intention was to flush it into the creek by installments.

At this stage of the game, the operator, through a misunderstanding of orders, opened the gates at a time when the sewage flow was five times the normal, and flushed the whole mass of sludge and scum into the stream. To make a thorough job of it, he filled and emptied the tank several times, so that its sides and bottom were thoroughly cleaned. This put the whole plant in such a condition that we had to begin a new ripening period. This was well under way when the explosion occurred.

The new deposits of raw or undecomposed sludge and the superimposed raw sewage generated more or less sulphureted hydrogen which caused considerable odor in the vicinity of the plant. Without having reported the odors or made any other reports which would have informed the writer of the generation of the gas, the operator, to clean up around the plant, set fire to a mass of dead weeds and grass that had accumulated near the side of the plant, in which there is a considerable crack at the line of the roof and sidewall. The gas escaping from the tank at this crack ignited from the flames of the burning grass and caused the gas in the tank to explode with very great force. It did no damage, other than to frighten the attendant out of his wits, as he thought that the end of time had come. He describes the explosion as having been somewhat on the order of a gunshot, only very much louder and heavier, and followed immediately by a heavy hissing noise which lasted for some seconds and which was accompanied by a very heavy emission of white smoke from the four manholes.

The fact that the four manhole covers, weighing about 100 lb. each, were not fastened accounts for the absence of damage to the plant. Had the manhole covers confined the gases of explosion within the tank for even a short time we would be operating today with a roofless tank, and in all probability with a new operator.

Annual Meeting of the Iowa Engineering Society

The 27th annual meeting of the Iowa Engineering Society was held at Iowa City, Feb. 17 to 19, 1915, with about 160 members and guests in attendance. Although a number of very good technical papers were presented the most important feature of the meeting was the consideration of certain governmental relations of, or possibly it may be better to say, governmental restrictions on the engineering profession in the state.

The first of these was in regard to the State Board of Health. As at present constituted that Board has a small appropriation and little but advisory functions, and to remedy this a bill is now before the Senate of Iowa conferring upon the Board large powers of supervision of the sanitation of communities, although no change is made in the organization of the Board or provision made for the financing of the projects which, under the proposed act, the Board may order. The act, at least in its statement of the scope of the Board's authority is based largely on the similar acts of certain of the Eastern States.

The second important subject under discussion was the activities of the so called Technical Service Bureau of the Iowa State College, at Ames. This bureau is of recent organization, and resembles an earlier, and until now unique, bureau conducted under the auspices of the University of Wisconsin. Its avowed intention is to offer gratis (except for minor expense charges) preliminary advice on any subject of engineering importance to municipality, business concern or presumably individual.

According to Dean Marston, of the State College, this sounds more sensational than the intention of the Bureau would warrant. In brief, it is thought that there are now many communities or concerns which go about certain engineering projects with no technical advice whatsoever, believing, as seems to be common in rural districts of the Middle West, that engineers are expensive superfluities. Such people are in need of education as to the necessity for trained engineers, and by offering them free preliminary advice, the Bureau hopes to be able to show them the desirability of engineering service, which, if required for any project on which the Bureau reports, must be engaged from outside the membership of the Bureau. The work is only just starting and is being conducted with a full knowledge of the chances of superseding the independent engineer, but there seems to be a quite large "twilight zone," in which the intentions of the Bureau and the field of the outside engineer will overlap. The State College is about to issue a bulletin giving in detail the conduct of the Bureau and its scope and program.

The secretary of the League of Iowa Municipalities, who was present at the meeting, claimed credit for the idea of an engineering advice bureau adjunct to the State College, and advanced the decidedly "progressive" opinion that it was the duty of the state colleges, in partial repayment for the financial aid of the state, to give free engineering services to the citizens of the state. Dean Marston refused agreement to this view and stated that those members of the State College faculty assigned to the Bureau would give only general advice and would not be allowed to accept any paid service in connection with any of the projects reported upon by the Bureau. At present, however, it does not seem clear whether other members of the faculty will accept such service.

Most of the engineers discussing the scheme seemed to fear the encroachment of the state on their domain and particularly opposed a directory of engineers which the Bureau proposes to submit to such of its clients as wish direct and paid engineering service.

The last governmental matter was the report of the Committee on Legislation that the engineers' licensing act had again been introduced into the Iowa Legislature. The Committee is in favor of the bill as introduced, which is peculiar to this state, in that it makes the licensing permissive instead of mandatory.

The important papers included illustrated talks by S. M. Woodward on "The Dayton, Ohio, Floor Relief Project," by Nelson P. Lewis, of New York City, on "City Planning," and by the President of the Society, Dean Raymond, of the State University of Iowa, on "The Public and Its Utilities."

A Single Sugar Pine Tree cut in the Stanislaus National Forest in California yielded 18,933 ft. b.m. of lumber. The tree was cut by a trespasser and the Forest Service collected in settlement for it nearly $100. The value of the lumber was set at $5.25 per M.

Meeting of the Minnesota Surveyors and Engineers

The annual meeting of the Minnesota Surveyors and Engineers Society at St. Paul, Minn., Feb. 19-20, 1915, was attended by about 100 members and guests and was marked by a faithful adherence to a rather lengthy program, made up mostly of papers relating to engineering practice in small towns and cities. As in the Iowa meeting reported on the preceding page, however, the feature of most interest to engineers in general was the discussion of the engineering advisory work being carried on in connection with the State University.

In its operation, the Minnesota plan seems radically to differ from that of Iowa, although both have been in operation so short a time that a direct comparison is hardly fair. In Minnesota the scheme originated in the League of Minnesota Municipalities, founded in 1913. This league is an association of some 130 towns, villages and cities banded together for mutual benefit, mainly in the way of education in municipal problems, and having for its executive officer the Director of the Extension Service of the State University. About coincident with the formation of the municipal league, the extension service of the University formed a Municipal Reference Bureau, whose function it is to answer questions on municipal matters put to it by any municipal corporation in the state (regardless of membership in the League). To this Bureau, however, the League has directed such of its members' questions as could not be easily answered by the central office. The service furnished by the Bureau has been of a varied nature, not easily described in few words or exactly understood by any but those intimately connected with the work. Apparently it has been the intention of its leaders not to encroach on the field of any of the established private professions or businesses, but whether they themselves have been able to draw a definite line where such encroachment begins is subject to doubt.

Within the past few months a new factor has entered the scheme in the shape of a Bureau of Engineering Cooperation. This bureau is, according to the secretary of the League, distinctly an adjunct to the League and has no connection with the extension service of the University. To it are referred all queries by municipality-members which require engineering advice and knowledge to answer. The engineering bureau answers without fee such of those questions as are of general import and requires no investigation or study and recommends certain engineers who, for proper compensation, will attack those problems of design or construction which demand more complete treatment.

At the meeting at St. Paul the secretary of the League defended the scheme entirely as a method of increasing municipal efficiency. Two or more cities, he said, have an undoubted right to combine for mutual education and to hire in any way they see fit such professional services as they may require. On the other hand, the general trend of the floor discussion, while admitting the justice but not the desirability of such a combination, was that the dangerous feature of the scheme was the connection, even though tenuous, between the Bureau of Engineering Coöperation and the State University of Minnesota. This connection, as described above, is further suggested by the fact that a part-time professor in the University is in charge of the Engineering Bureau and has control of the parceling out of such engineering work as comes to the Bureau.

It should be said that those connected with the engineering bureau are not at all settled as to the manner of conducting it, that they realize the delicate ground on which they are treading and that they hope so to control and regulate it that "two engineering jobs will grow where one grew before." The feeling of the meeting was evidently adverse to the scheme, but pending further information as to its operation, no action was taken.

Resolutions were passed commending the State Highway Commission, which is now under fire of political opposition, and urging its continuance upon the Legislature. A State drainage act, now before the Legislature, was also approved.

The president elected for the ensuing year is W. H. Hoyt, Asst. Chief Engineer of the Duluth, Missabe & Northern Ry. The secretary is George H. Herrold, City Hall, St. Paul, Minn.

News of the Engineering World

Passaic Valley Sewer Progress

Good progress on the construction of the Passaic Valley sewerage project was reported in a statement as of Feb. 1, 1915, just submitted to the Newark Board of Trade by the Passaic Valley Sewerage Commission. The task of the commissioners is to build a trunk sewer from Paterson to Newark, a pumping station and treatment plant, a tunnel beneath Newark Bay, the Bayonne peninsula and a part of New York Bay, and diffusion works near Robbins' Reef. To Feb. 1, 1915, the Commission has awarded contracts amounting to $9,836,474. Of the 111,838 ft. of trunk sewer from Paterson to the Newark Bay pumping station, 68,266 ft., or 61%, have been completed. All the rest is under contract, except a short section in Newark, recently advertised. Contracts for the three 100,000,000-gal. pumps and auxiliaries and the foundations and connections for the pumping station have also been let. Of the 33,758 ft. of outfall tunnel, 7200 ft., or 21%, have been completed. The system will serve at least 17 municipalities, five of those included in the original project not yet having come in and two (Haledon and Prospect Park) having been admitted under the provisions of a legislative act of 1914. The lawsuit to prevent the discharge of sewage from this system into New York Bay, begun in 1908 by New York State in behalf of New York City, has not yet been argued, although the taking of testimony was completed in July, 1913. As the Commission is already under stipulatory agreement with the United States Government to so treat the sewage that its dis-

charge into New York Bay will not create a nuisance, the Commission feels, according to its statement, that it has nothing to fear from the outcome of the suit. Wm. M. Brown is Chief Engineer and Wm. Gavin Taylor is Deputy Chief Engineer of the Passaic Valley Sewerage Commissioners, Newark, N. J.

Replacing a 100-ft. Steel Bridge Span in Five Hours

A single-deck span of the Second Ave. bridge, carrying the Third Ave. elevated-railway line over the Harlem River, New York City, was lifted on scows by tide action, towed out of the way, and replaced by a new double-deck span, all between 2 and 7 a.m. on Monday, Feb. 22. Both were through Pratt-truss bridges with pin connections. The span length is 101 ft. 10½ in. The trusses of the new bridge are 26 ft. c. to c. at the north end and 40 ft. 11⅜ in. c. to c. at the south. The difference is due to a spread of track on account of a switch placed on the bridge. The total weight of span and floor system is 375 tons.

The new bridge had been erected on pile falsework along the river bank, near the bridge site. On the tide preceding the one used in removing the old span, the new structure was taken on two 28½x92-ft. scows which were slipped under the span through openings left in the falsework. As the tide rose, the span was picked up on framed bents erected on the scows. The span thus floated was then towed to a point near the bridge site. On the following tide two scows were floated under the old span and a half-hour before traffic was stopped (2 a.m. on Feb. 22) blocking was started. In addition to utilizing the rise of the tide, hydraulic jacks were used, to save time.

As soon as the old span was towed out of the way, the scows carrying the new one were floated into position. Before the new span was lowered the old shoes and expansion rollers were replaced by new sets. The new span was steadied by tackle and was lowered by means of sand jacks, six to a scow.

The work was done for the Interborough Rapid Transit Co. (under the direction of F. W. Gardiner, Principal Assistant Engineer, C. E. Carpenter, Maintenance Engineer, and Bernard O'Rourke, Section Engineer) by Terry & Tench (H. D. Robinson, Engineer-in-Charge, and W. L. Cline, General Superintendent).

Sanitary Survey of Fort Worth

A report on a sanitary survey of Fort Worth, Tex., has just been made to the City Commissioners by Hering & Gregory, of New York City. The survey embraced sewerage, sewage disposal, garbage and refuse collection and disposal, and street cleaning.

Fort Worth had a population of 73,312 in 1910. Its present population is estimated at 90,000. It is sewered on the separate plan, with 129 mi. of sanitary and 8 mi. of storm sewers, compared with 152 mi. of "improved" and 62 mi. of paved streets (not including alleys). The sewage is discharged into the Trinity River, untreated. Although the stream has a drainage area of 2400 sq.mi., it has practically no flow in very dry weather. About 72,000 people are supplied with city water and 55,000 with sewers. The making of sewer extensions and connections has progressed slowly of late. The report recommends that all water consumers be metered and that all houses on sewered streets be connected with the sewers. Sewage-treatment works are recommended, consisting of coarse screens, grit chambers, Imhoff tanks and sludge beds, a pumping plant, sprinkling filters, and final settling tanks. Such works would cost $655,000, and an outfall sewer $126,500 more, making a total of $782,000. If funds were short, clarification works could be built for $236,000, but the outlay for an outfall sewer would still be necessary. The estimates are based on an ultimate daily volume of 12,500,000 gal., of which 2,500,000 gal. would come from territory outside the city, including packing houses.

Municipal collection of garbage, rubbish and ashes, with disposal by means of a high-temperature incinerator, and with heat utilization, is recommended, and also improvements and extensions of the street-cleaning service, but no cost estimates are given. If the city cannot stand the expense of an incineration plant just now, disposal by properly controlled dumping, with burial of garbage, is advised.

A topographical survey of the city, the collection of data regarding the sewerage system and sewage flow, and a study of street cleaning, with a view of devising improved methods, are advised.

The authors of the report credit F. J. Von Zuben, City Engineer of Fort Worth, with assistance in the collection of information and commend "the organization and personnel of the engineering department" of the city. The field work of the survey was done by John H. Gregory, of Hering & Gregory, and by Charles Saville, formerly of that firm.

Three-Cent Fares Denied

The first application for three-cent street-railway fares to come before the Public Service Commission for the Second District of New York has just been denied. The case was that of the city of Rochester vs. the New York State Rys. The opinion was written by M. S. Decker. The city contended that the company could afford to make the reduction, that the increased traffic would bring up the revenues and that the city's large working population would establish itself outside the congested districts. The Commission found that three-cent fares with existing traffic would bring the company only 4.6% return on property within the city five-cent zone, that a 20% increase of business would be necessary to reimburse the company for the cut and that this increase would come at rush hours when the system was already overtaxed.

The Boston Dry-Dock Project

Whether Boston shall or shall not have the projected dry dock on which a half million dollars have been spent and for the prosecution of which a two-million dollar contract has been pending execution for a long time is a question put squarely up to the Massachusetts Legislature by Governor Walsh in a special message on Feb. 18.

In 1904, the Massachusetts Board of Harbor and Land Commissioners and in 1911 a joint legislative committee, advised against a dry dock, but the Legislature of 1911 instructed the newly created Board of Directors of the Port of Boston to report to it plans and estimates for a

dry dock of size and equipment sufficient to accommodate "any modern ocean steamship."

Early in 1912, the Port Directors submitted a tentative estimate of $3,000,000, and in their report for 1912-13 they included both plans and estimates. Although the legislature of 1911 had called for these plans and estimates, neither the 1912 nor the 1913 legislature took action on them. Nevertheless, the Port Directors, on Oct. 23, 1913, with the approval of the Governor and Council, made tentative agreements with three steamship companies under which the companies were to pay not less than $50,000 for the use of a dry dock when built. The Port Directors also expended or contracted to spend $467,694 on work preparatory to building a dry dock, and awarded a contract for a stone and concrete dry dock to the Holbrook, Cabot & Rollins Corporation, for $1,846,583. On June 26, 1914, the proposed contract went to the Governor and Council for approval.

In August, 1914, the personnel of the Port Directors was changed by legislative enactment. On Sept. 2, 1914, the contract was returned by the Governor and Council to the new Port Directors for further investigation and report. On Dec. 17, 1914, Civil Engineer F. R. Harris, U. S. N., to whom the matter had been referred, submitted a favorable report on the specifications and contract. On Jan. 28, 1915, the Attorney General expressed the belief that the Port Directors would not be warranted in awarding the dry-dock contract without further authorization from the Legislature.

Governor Walsh points out that, even if the dry dock is built within the estimate, its total cost, including items not yet contracted for, will be $3,231,134, leaving a balance of only $858,260 in the port loan fund. He also states that the dry dock would produce an "annual deficit of $140,727 as a subsidy for a dry dock in Boston harbor." The Port Directors urge that the dry dock would attract the largest commercial and naval ships to Boston, since it would be the only one of sufficient size to serve those ships. Indirectly, therefore, the deficit would be decreased from year to year. Governor Walsh suggests, in conclusion, that if the dry dock is built (which he seems to favor in view of the expenditures already made and obligations incurred) then Congress should be asked to contribute toward the annual maintenance charges, in view of the usefulness of the dry dock to the Navy Department.

Gasoline from "Synthetic Crude Oil"

The production of synthetic "crude oil" from various residual hydrocarbons, such as vaseline, rodwax, gas oil, fuel oil, etc., has been accomplished by Dr. Walter O. Snelling of Pittsburgh, Penn., according to his statement before the division of petroleum and gas at the recent meeting of the American Institute of Mining Engineers in New York City. From these hydrocarbons, low in hydrogen, there was repeatedly obtained a "synthetic crude oil" from which gasoline aggregating from 50 to 70% was distilled, after successive reconversion of the residue into synthetic crude oil. The excess carbon separated out as mud. First, 18% of gasoline came off; then 15%, 12%, etc., were successively obtained. Starting with paraffin residue, the eventual yield was 70% of water-white gasoline and about 30% of natural

The gasoline distilled from the synthetic crude oil is normal in color but of milder and sweeter odor than the product of natural crude petroleum. The gasoline is reported to be suitable as motor fuel and other customary uses of ordinary gasoline.

According to Dr. Snelling's remarks as reported in the *Engineering and Mining Journal*, Feb. 20, his experiments showed that when a hydrocarbon body occupying more than one-tenth and less than one-half of a vessel is heated under a pressure of 800 to 900 lb. a fundamental change occurs, the hydrogen and carbon atoms rearranging themselves and forming a more or less definite mixture of hydrocarbons in appearance and constitution not unlike crude oil.

An Explosion Wrecked a Two-Story Brick Building in Toledo, Ohio, on Feb. 13, killing two men. No fire ensued and the cause has not been found, according to press dispatches.

A 25-Ft. Brick Wall Under Construction Collapsed on Feb. 13 in Louisville, Ky., injuring four bricklayers. Press dispatches state that the wall had been weakened by a cut at its base for keying in a concrete floor.

A Coal-Mine Explosion in Wilkes-Barre, Penn., killed eight mine workers and injured six others. The accident occurred at a point nearly two miles from the shaft. The fire caused by the explosion was extinguished before it gained much headway.

Locomotive Sparks caused 60% of the forest fires which occurred in 1914 in the national forests in the White Mountains and the southern Appalachian region. The Federal Forest Service reports that 503 forest fires occurred in these areas during the year, of which 319 were traced to locomotive sparks.

A "Norther" at Limon Bay, C. Z., on Feb. 8-10, carried away 4000 ft. of trestle built for the east breakwater which is being constructed from Coco Solo Point toward the canal channel. The "Canal Record" for Feb. 10 states that two piledrivers and a train of 21 flat-cars with the unloader were lost. The damage to the trestle and tracks on the night of Feb. 8 was so extensive that next day effort was made to bring to land the rolling stock on the trestle. However, a portion of trestle between the cars and the shore was washed out, leaving 69 men marooned. These men were rescued with considerable difficulty by lifeboats from the dredge "Caribbean" and the tug "Potomac."

Gas Explosion in an Empty Sewer—An explosion in a new 36-in. pipe storm-water sewer at Grand View, N. J., Feb. 22, probably resulted in the destruction of 500 to 1000 ft. of the pipe. The sewer was only recently completed and had not as yet been accepted from the contractor. Below the 36-in. storm-water sewer was an 18-in. sanitary sewer, at a depth of 16 or 18 ft. below the street level. The storm-water sewer was about 3 ft. above the sanitary sewer. Paralleling the two sewers, about 6 ft. distant, but considerably higher in elevation, is a 12-in. high-pressure gas main of the Public Service Corporation of New Jersey, supplying all northern New Jersey towns. It is supposed that blasting for the sewer trench opened joints in the gas main and that gas had been accumulating in the empty sewer pipes for several weeks. The sewer pipe was laid on a 3 or 4% grade and the first explosion occurred about 2 o'clock in the morning at a point some 700 or 800 ft. down the sewer from the place where the most violent explosion took place. There are reported to have been a series of six or seven explosions, following one another up the grade in rapid succession. The amount of damage to the sewer cannot be determined, of course, until it is all uncovered. The explosions were so violent in two places as to tear large holes in the street and to wreck two or three manholes. The engineers of the sewerage system of Fair View, of which this is a part, are Darling & Bowes, of West New York, N. J. The contractor is John J. McGarry, of Edgewater, N. J.

Competitive Plans for a New Public Library for Cleveland, Ohio, are to be invited soon. The competition will be restricted to seven architects, two from Cleveland and five from other cities, selected by the Library Board in conjunction with Prof. A. D. F. Hamlin, its professional advisor. The estimated cost of the building, exclusive of equipment, is

$1,800,00[illegible] The new building will form a part of the civic group a[illegible] will conform with the other buildings in the group in heigh[illegible]nd general design. It will be located on the site of the [illegible] City Hall, which is still in use but which will be aban[illegible]ed on the completion of the new City Hall.

PERSONALS

Mr. [illegible] S. Gallagher has been made Assistant Engineer in charge of car design and specifications of the Lake Shore & Michigan Southern Ry., with office at New York City.

Mr. H. E. Smith, Chemist and Engineer of Tests of the Lake Shore & Michigan Southern Ry., Collinwood, Ohio, has been given supervision of laboratories and material inspection.

Mr. Joseph T. Richards, Consulting Engineer to the Maintenance-of-Way Department of the Pennsylvania R.R., at Philadelphia, will retire March 1, under the company's pension rules.

Mr. H. E. Pulver, Instructor in Mechanics at the University of Wisconsin, has been appointed Assistant Professor of Civil Engineering at the Chinese Imperial Polytechnic Institute, at Shanghai, China.

Mr. R. M. Brown has been appointed Assistant Engineer in charge of engineering and drafting at the locomotive and car shops of the Lake Shore & Michigan Southern Ry., with office at Cleveland, Ohio.

Mr. Andrew A. Woods, M. Am. Soc. C. E., Resident Engineer of the New Orleans & North Eastern R.R. at New Orleans, La., has been made Superintendent of the road, succeeding the late S. E. Flanagan.

Mr. R. W. Stevens, Superintendent of the Chicago & Western Indiana R.R., at Chicago, has been appointed General Superintendent, to succeed Mr. J. M. Warner, who had the title of General Manager.

Mr. W. B. Geiser, Acting Chemist and Engineer of Tests of the New York Central & Hudson River R.R. Co., has been made Assistant Chemist and Engineer of Tests, with headquarters at West Albany, N. Y.

Mr. A. R. Ayers, General Mechanical Engineer of the Lake Shore & Michigan Southern Ry. and other New York Central lines west of Buffalo, has been appointed Principal Assistant Engineer, with office at New York.

Mr. P. P. Mirtz, Mechanical Engineer of the Lake Shore & Michigan Southern Ry., has been appointed Assistant Engineer in charge of locomotive design and specifications, with headquarters at New York City.

Mr. Paul Seurot, M. Am. Soc. C. E., Chief Engineer for Jacobs & Davies Inc., Montreal, Que., has been awarded the Gzowski Medal of the Canadian Society of Civil Engineers for the best paper of the year 1914.

Mr. John S. Huey, formerly connected with the Allis-Chalmers Co., has been appointed District Sales Manager of the Kerr Turbine Co., of Wellsville, N. Y., for Louisiana and southern Mississippi. His office will be at 418 Hibernia Bank Bldg., New Orleans, La.

Mr. Walter G. Kirkpatrick, M. Am. Soc. C. E., recently City Engineer of Birmingham, Ala., and Special Engineer in the Executive Department of the Alabama Power Co., has opened an office at 703-704 Farley Building, Birmingham, to again take up the general practice of engineering he formerly conducted.

Mr. R. M. Hosea, of Pueblo, Colo., has resigned his position as Chief Engineer of the Colorado Fuel & Iron Co., the Colorado & Wyoming Refining Co. and the Crystal River R.R. He retains a connection with these concerns as Consulting Engineer, and will undertake private practice in engineering and mining work.

Mr. Charles W. Hotchkiss, M. Am. Soc. C. E., Chief Engineer and General Manager of the Chicago, Indiana & Southern R.R. and the Indiana Harbor Belt R.R., has been elected Chairman of the Board and of the Executive Committee of the Virginian Ry., with headquarters at New York. Mr. Hotchkiss began railway work in 1886, as rodman on construction work with the New York, West Shore & Buffalo R.R.

Mr. Raymond Du Puy, formerly Vice-President and General Manager of the Virginian Ry., has been elected President of that road, with headquarters at Norfolk, Va. Mr. Du Puy was born at Pittsburgh in 1860, and received his education at Georgetown University. He began work as a water-boy on the Missouri, Kansas & Texas Ry., in 1877. In 1905 he was appointed General Manager of the Tidewater and the Deepwater Rys. at Norfolk, Va., which were afterward consolidated to form the Virginian Ry.

Mr. H. S. Morse, M. Am. Soc. C. E., former Chief of the Sewerage Division of the Department of Public Works of Cincinnati, Ohio, has been chosen, by the trustees of the Cincinnati Bureau of Municipal Research, Director of the Bureau. Mr. Morse will continue his connection with the Ohio Institute for Public Efficiency at Columbus as Engineer. He is a civil-engineer graduate of the Massachusetts Institute of Technology and previous to going to Cincinnati was with the Sewerage Commission of Louisville, Ky.

Mr. Hiram N. Savage, M. Am. Soc. C. E., has severed his connection with the U. S. Reclamation Service, as Supervising Engineer of the U. S. Geological Survey Bureau of Arid Land Reclamation Service. The work of his office will hereafter be handled in the office of the Secretary of the Interior. Mr. Savage was one of the four engineers of the Reclamation Service who passed upon all the irrigation plans of the U. S. Geologic Survey. Press reports state that Mr. Savage will devote his time to private practice and will make his headquarters at Billings, Mont.

Mr. Edward Nash Hurley, President of the Hurley Machine Co., of Chicago, and President of the First National Bank of Wheaton, Ill., has been appointed by President Wilson a member of the Federal Trade Commission, to serve six years. Mr. Hurley is a native of Galesburg, Ill. He has been a prominent figure in the development of the pneumatic tool industry in the United States and Europe. In 1896 he organized the Standard Pneumatic Tool Co., of Chicago. In 1913 Mr. Hurley was appointed United States Trade Commissioner to Latin-American republics. He is President of the Illinois Manufacturers' Association.

Mr. Robert M. Feustel, Chief Engineer of the State Public Utilities Commission of Illinois, has tendered his resignation to the Commission to take effect Mar. 1. Mr. Feustel is a member of the firm of Sloan, Huddle, Feustel & Freeman, Consulting Engineers of Madison, Wis., and was formerly Assistant Chief Engineer of the Railroad Commission of Wisconsin. His withdrawal at this time is for the purpose of resuming his consulting engineering practice with the above firm, which practice he temporarily relinquished in order to organize the Engineering Department for the Illinois Commission. It is understood that the Commission has not as yet determined upon the successor for this position.

Mr. William C. Armstrong, M. Am. Soc. C. E., Engineer of Bridges of the Chicago & Northwestern Ry., at Chicago, has been appointed Chief Engineer of the St. Paul Union Depot Co., of St. Paul, and will be in charge of the construction of the new union station. Mr. Armstrong graduated from Iowa State College in 1881, and began his railway work the following year as draftsman with the Wisconsin, Iowa & Nebraska Ry. He entered the service of the Chicago & Northwestern in 1899, as Resident Engineer, and was made Bridge Engineer in 1902. In 1905 he became Superintendent of Construction of the Missouri Pacific Ry., at Sedalia, Mo., and the next year he went with the Chicago, Rock Island & Pacific Ry., as Bridge Engineer, at Chicago. In 1907 Mr. Armstrong returned to the Chicago & Northwestern as Terminal Engineer at Chicago, and in 1912 was appointed to the position he now resigns.

OBITUARY

George Gibson Barret, General Manager of the Cleveland Drop Forge Co., and for many years connected with the American Locomotive Works, died recently at his home in Commack, L. I., at 67 years of age.

William F. Gurley, President of W. & L. E. Gurley, of Troy, N. Y., died on Feb. 17, at Atlantic City, N. J., where he had gone in the hope of regaining his health. Mr. Gurley was a son of L. E. Gurley, one of the founders of the firm. After his graduation from Williams College Mr. Gurley entered the factory of his father and uncle and upon the death of his uncle, William Gurley, entered into partnership with his father. Mr. Gurley was the first President of the Chamber of Commerce of Troy. He was interested in many of the religious and charitable organizations and in educational and public affairs of his home city. Mr. Gurley was 55 years old and is survived by a widow and a daughter, Mrs. H. M. Dibert, of Troy.

H. Ward Leonard, M. Am. Inst. E. E., well known electrical engineer and inventor, died at New York on Jan. 18 from

apoplexy. He was in his 55th year. Mr. Leonard was a native of Cincinnati, Ohio, and was a graduate of the Massachusetts Institute of Technology. Soon after graduation he became associated with Thomas A. Edison and was one of a staff of engineers selected to introduce the Edison central station system. Mr. Leonard afterward formed the firm of Leonard & Izard, which eventually was bought out by the Edison interests after which he became General Manager of the Edison interests for the United States and Canada. In 1891 he completed the Ward Leonard system of motor control, which was one of a great many of his important electrical inventions. Mr. Leonard was the founder of the H. Ward Leonard Mfg. Co., of Bronxville, N. Y.

ENGINEERING SOCIETIES

COMING MEETINGS

ILLINOIS WATER SUPPLY ASSOCIATION.
Mar. 9-11. Annual convention at University of Illinois. Secy., Edward Bartow, Urbana, Ill.

AMERICAN RAILWAY ENGINEERING ASSOCIATION.
Mar. 16-18. Annual meeting at Chicago, Ill. Secy., E. H. Fritch, 900 So. Michigan Ave., Chicago, Ill.

LAKE MICHIGAN WATER COMMISSION.
Mar. 19. Meeting at Milwaukee, Wis. Secy., Edward Bartow, Director, Illinois Water Survey, Urbana, Ill.

Northwest Mining Convention—A mining convention was held in the week of Feb. 22 at Spokane, Wash., under the auspices of the Mining Men's Club, Spokane Chamber of Commerce, Spokane Engineering and Technical Association and the local sections of the national societies of civil, mining and electrical engineers. There was an exhibit of ores, minerals, photographs, machinery, etc., and a program of general and technical papers.

San Francisco Association of Members of the American Society of Civil Engineers—At the annual meeting, on Feb. 18, the following officers were elected: President, A. M. Hunt; Vice-President, M. C. Couchot; Secretary, E. E. Thurston, Jr.

Appliances and Materials

Nonrattling Manhole Cover

The manhole cover shown in the accompanying illustration is tight fitting, does not rock or rattle, and requires no separate lock or other fastening. The cover is made with a slotted flange which forms lugs to engage with lugs in the manhole casting. The faces of the lugs are inclined so that the cover has a circular movement as it drops into position or is lifted out, and thus it cannot be tilted by wagon wheels passing over it. The weight is carried on the inclined faces of the lugs and not on their upper edges, so that the seating of the cover is not affected by dirt accumulating on the horizontal surfaces. As each lug has one face inclined at 45° and the other at 60°, only one face takes a bearing, so that the cover cannot jam. This makes it easy to lift and remove.

NONRATTLING MANHOLE COVER

The cover is in use at Chicago by the city water department, the electrical department and the South Park Commission; it is in use also at St. Paul and Minneapolis for city manholes and on those of the Tri-State Telephone Co. It is adapted also for coalholes at schools and other large buildings. For a manhole with 24-in. cover the weight of cover and frame is about 540 lb.

This manhole cover is the invention of Owen T. Dougherty, St. Paul, Minn., and is made by William E. Dee Co., 30 No. La Salle St., Chicago.

* * *

Allis-Chalmers Tractor-Truck

A combined tractor and truck with caterpillar belts in place of large rear wheels has just been developed by the Allis-Chalmers Manufacturing Co., of Milwaukee. As a tractor it is intended for general service; as a truck it is adapted for use where the usual type cannot be used because of rough country. The machine has four speeds forward—1½, 3½, 6 and 8-10 mi. per hr.—and one reverse—1¼ mi. per hr. The first three speeds the machine, as a tractor, has a d[illegible] pull of 9000, 4125 and 2370 lb. respectively. The four[illegible] is recommended only for the machine as a truck w[illegible]

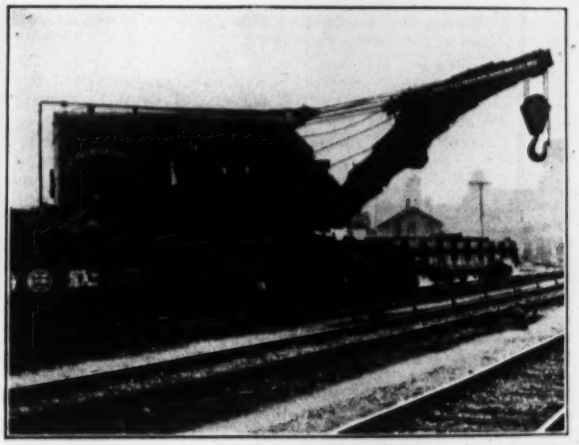
CATERPILLAR TRACTOR-TRUCK

loads and in emergencies. This tractor-truck shows the usual features now recognized in good motor-vehicle design, including use of alloy steels at important points; the engine is a four-cylinder type rated for 68 hp. at 1000 r.p.m.

* * *

Steam-Electric Tunnel Wrecking Crane

An interesting wrecking crane has recently been built by the Industrial Works, of Bay City, Mich., for the Michigan Central R.R., to be used in and about its Detroit River tunnel. The crane is much like the 120-ton steam cranes used by American railroads, except that it is designed for working in tunnel clearances and has both steam engines and electric motors but no boiler. For operation outside the electric zone steam is taken from a locomotive; a tight slip joint is provided at the center of revolution. The motor is a 600-volt direct-current type rated at 200 hp. for short runs and at



STEAM-ELECTRIC TUNNEL CRANE; MICHIGAN CENTRAL R.R.

115 hp. for 1-hr. Current is delivered to the revolving table by collector rings, being obtained direct from the third-rail shoes or through a 500-ft. cable. The latter is on an automatic motor-driven reel; the reel motor has current through it all the time and thus keeps the cable taut but allows it to pay out when a definite pull is given.

The main- and auxiliary-hoist and the boom and slewing motions are independent but can be simultaneously used. Under maximum load of 120 tons the crane will slew at rates of up to 1 r.p.m. The crane car has, when self propelled, a speed of 4 mi. per hr., but it can be safely hauled at speeds of up to 60 mi. per hr.